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ENVIRONMENTAL CONCERNS AFFILIATED WITH THE OPERATIONS OF THE UNITED ASBESTOS INCORPORATED MINE/MILL COMPLEX MIDLOTHIAN TOWNSHIP

November 1976

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ENVIRONMENTAL CONCERNS AFFILIATED WITH THE OPERATIONS OF THE UNITED ASBESTOS INCORPORATED MINE/MILL COMPLEX MIDLOTHIAN TOWNSHIP

PREPARED BY: CHRISTOPHER R. GIBSON

FOR THE INDUSTRIAL ABATEMENT SECTION

OF THE

ONTARIO MINISTRY OF THE ENVIRONMENT

NORTHEASTERN REGION

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SUMMARY ABSTRACT

When concern arose regarding serious health effects associated with the mineral "CHRYSOTILE ASBESTOS", the Ontario Ministry of the Environment launched a massive program in Ontario to evaluate; 1) sources of emissions, 2) techniques in analytical measurement, 3) and properties of asbestos in general.

In the Northeastern Region of Ontario there was a unique opportunity to monitor a new chrysotile mine/mill complex before and after it started production. This mine is the United Asbestos Inc. Midlothian Mine some seventeen miles west of the tiny Northern Ontario community of Matachewan.

In this report, an attempt has been made to review the environmental problems associated with the mining and milling of chrysotile fibre from the United Asbestos Midlothian mine/mill operation in Northeastern Ontario.

Christopher R. Gibson

PREFACE

Before an attempt is made to describe areas of environmental concern from the mining and milling asbestos operations near Matachewan, Ontario, a brief on the properties of asbestos (especially the variety mined at the United Asbestos Midlothian Mine) is as follows.

CHRYSOTILE

Chrysotile asbestos is similar to kaolinite having the chemical structural breakdown of -
0.1 - 5.0% Fe_2O_3; 39.44% MgO; 0.2-1.5% Al_2O_3; 0.0-6.0% FeO; 37-44% SiO_2; 0.0-5.0% CaO; and 12.0-15.0% H_2O.
The fibres of chrysotile asbestos (taking an average diameter of 1 um) can yield approximately 1000 fibrils of the same length, indicating we are dealing with very small matter.

The structure of chrysotile lies in veins of serpentine, altered peridotite and limestone near basic igneous rocks. Veining occurs in either slip or cross fibres and the asbestos has a specific gravity of 2.5 - 4.0. The refractive index is from 1.50 to 1.55 and its acid resistance characteristic is soluble up to roughly 57%.
Refer to Properties of Asbestos Fibres pages 5 and 6.

Iron is one of the main metals that is associated with both the fibre and its matrix. Its concentration is roughly 2.0 - 4.8% in content.

Canadian deposits of chrysotile asbestos contain approximately 100-1200 ugm/gm Cr; approximately 100 ugm/gm Co and approximately 100-2000 ugm/gm Ni. Chrysotile asbestos represents approximately 95% of the world's commercial fibre production.

In general, asbestos fibres can be broken down to extremely fine dimensions (1000th the diameter of a human hair). This is turn, makes it a very useful material for reinforcing cement, plastics and rubber, or it can be spun or woven into yarn or cloth for clutch facings, brake linings and protective clothing.

For comparison, the following properties of six (6) varieties of asbestos are tabulated on pages 5 and 6.

PROPERTIES OF ASBESTOS FIBRES

PROPERTY	ACTINOLITE	AMOSITE	ANTHOPHYLITE	CHRYSTOTILE	CROCIDOLITE	TREMOLITE
Structure	Reticulated long prismatic crystals and fibres	Lamellar. Coarse to fine fibrous and asbestiform	Lamellar. Fibrous asbestiform	Usually highly fibrous fibres fines and easily separable	Fibrous in iron-stones	Long. Prismatic and fibrous aggregates
Mineral..... Association	In Limestone and in crystalline schists	In crystalline schists etc.	In crystalline schists and gneisses	In altered peridotite adjacent to serpentine and limestone near contact with basic igneous rocks	Iron rich silicious argillite in quartzone schists	In Mg limestones as alteration products of highly magnesian rocks.
Origin.....	Results of contact metamorphism	Metamorphic	Metamorphic Usually from olivine	Alteration and metamorphism of basic igneous rocks rich in magnesian silicates	Regional metamorphism	Metamorphic
Veining.....	Slip or mass fibre	Cross fibre	Slip. Mass fibre unoriented and interlacing	Cross and slip fibres	Cross fibre	Slip or mass fibre
Essential..... Composition	Ca.Mg.Fe.Silicate water up to 5 pct	Silicate of Fe and Mg higher iron than anthophyllite	Mg silicate with iron	Hydrosilicate of magnesium	Silicate of Na and Fe with some water	Ca and Mg silicate with some water
Theoretical..... Formula	$Ca(Mg.Fe)_3(SiO_3)_4 \times H_2O$	$(Fe.Mg)SiO_3$. 1-5 pct H_2O	$(Mg.Fe)_7Si_8O_{22}(OH)_2$	$3MgO.2SiO_22H_2O$	$NaFe(SiO_3)_2 FeSiO_3 \times H_2O$	$Ca_2Mg_5Si_8O_{22}(OH)_2$

PROPERTIES OF ASEBSTOS FIBRES (cond't)

PROPERTY	ACTINOLITE	AMOSITE	ANTHOPHYLITE	CHRYSTOLITE	CROCIDOLITE	TREMOLITE
Crystal Structure	Long and tin columnar to fibrous	Prismatic, Lamellar to fibrous	Prismatic. Lamellar to fibrous	Fibrous and asbestiform	Fibrous	Long and thin columnar to fibrous
Crystal System	Monoclinic	Monoclinic	Orthohombic	Monoclinic (pseudo-orthohombic^{s})	Monoclinic	Monoclinic
Colour	Greenish	Ash gray or brown	Grayish white. Brown-gray or green	White. Gray. Green Yellowish	Lavender-Blue Metallic-Blue	Gray-white Greenish Yellowish Bluish
Lustre	Silky	Vitreous.Somewhat pearly	Vitreous to pearly	Silky	Silky to dull	Silky
Hardness.....	6±	5.5-6.0	5.5-6.0	2.5-4.0	4	5.5
Specific..... Gravity	3.0-3.2	3.1-3.25	2.85-3.1	2.4-2.6	3.2-3.3	2.9-3.2
Cleavage.....	110 Perfect	110 Perfect	110 Perfect	010 Perfect	110 Perfect	110 Perfect
Optical Properties	Biaxial negative extinction inclined	Biaxial and positive extinction parallel	Biaxial positive extinction parallel	Biaxial positive extinction parallel	Biaxial ± extinction inclined	Biaxial negative extinction inclined
Refractive Index	1.63 + weakly pleochroic	1.64±	1.61±	1.51-1.55	1.7 pleochroic	1.61±
Length	Short to long	2" to 11" varies	Short	Short to long	Short to Long	Short to long
Texture.....	Harsh	Coarse but somewhat pliable	Harsh	Soft to harsh. Also silky	Soft to harsh	Generally harsh sometimes soft

GENERAL MODE OF OCCURRENCE FOR CANADIAN CHRYSOTILE IN SERPENTINIZED ULTRABASIC ROCKS

Verbatum from "Asbestos in Ontario"
Department of Mines circular.

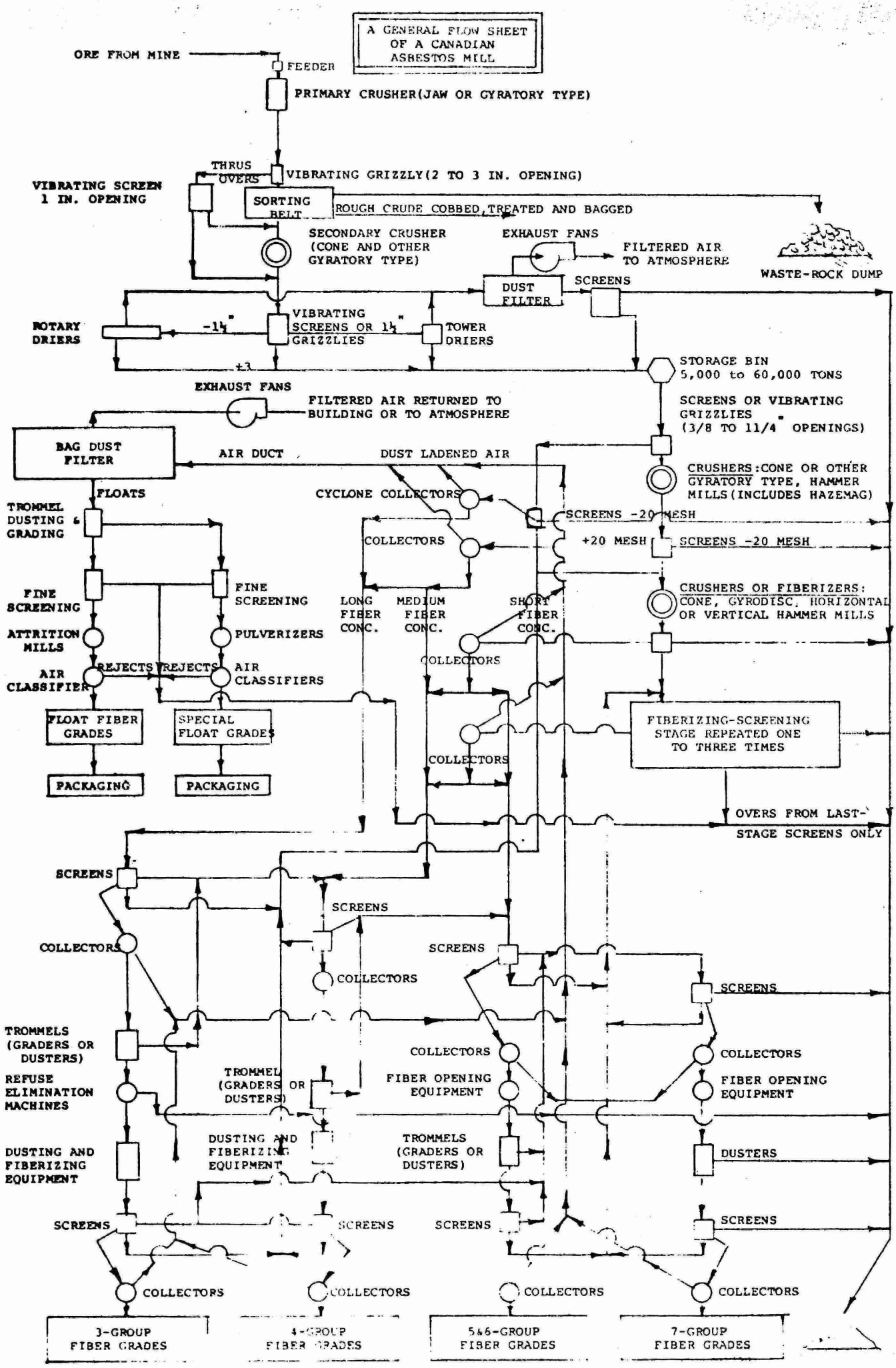
The most important host rocks for chrysotile asbestos are the olivine - bearing ultrabasic intrusives: dunite, composed almost entirely of olivine; peridotite, composed of olivine and pyroxene; and olivine pyroxenite, composed predominantly of pyroxene with some olivine. These intrusives occur as elongated stocks, often grouped in linear bands, and as sills, which may pinch and swell in an irregular manner. These ultrabasic intrusives appear to be spatially related to zones of major faulting and mountain - building movement. It has been pointed out that belts of peridotites often occur near the central axis of deformation of major mountain systems, such as the Appalachian system in the eastern townships of Quebec and the ancient Archean systems in northeastern Ontario.

These ultrabasic rocks are often altered through metamorphism to serpentine $H_4Mg_3Si_2O_9$. The common serpentine material formed is antigorite.

Chrysotile and antigorite have the same chemical composition and are dimorphous forms of serpentine formed under different conditions.

Chrysotile occurs in cross-fibre and slip-fibre veinlets cutting the serpentinized rock in a mesh or network pattern. On weathered surface the ultrabasic rock is white, green, or reddish-brown and is often cut up into oblong blocks by the seams of chrysotile, which weather out more easily, forming furrows across the outcrop. On fresh surfaces the rock is green or almost black. Conditions necessary for the formation of chrysotile veinlets are thought to be: (a) a suitable ultrabasic host rock, probably, but not necessary, already serpentinized; (b) faulting, to fracture the ultrabasic host rock and provide access for chrysotile - forming solutions; (c) a source of hydrothermal solutions and proper conditions of chrysotile in the fractured, serpentinized ultrabasic rocks, these may be the source of asbestos - forming hydrothermal solutions, and asbestos deposits may be localized in the ultrabasic rocks near such intrusives.

The flow diagram shown on the following page 10 is a generalization of the essential steps and equipment used in Canada for the preparation of raw asbestos fibre for marketing. It is totally based on the dry process, which incidentally has been utilized in Canada for almost sixty years.


A GENERAL FLOW SHEET OF A CANADIAN ASBESTOS MILL
ORE FROM MINE
FEEDER
PRIMARY CRUSHER(JAW OR GYRATORY TYPE)
THRUS OVERS
VIBRATING GRIZZLY(2 TO 3 IN. OPENING)
VIBRATING SCREEN 1 IN. OPENING
SORTING BELT
ROUGH CRUDE COBBED, TREATED AND BAGGED
SECONDARY CRUSHER (CONE AND OTHER GYRATORY TYPE)
EXHAUST FANS
FILTERED AIR TO ATMOSPHERE
WASTE-ROCK DUMP
DUST FILTER
SCREENS
ROTARY DRIERS
-1¼"
VIBRATING SCREENS OR 1¼" GRIZZLIES
TOWER DRIERS
+1
STORAGE BIN 5,000 to 60,000 TONS
EXHAUST FANS
FILTERED AIR RETURNED TO BUILDING OR TO ATMOSPHERE
SCREENS OR VIBRATING GRIZZLIES (3/8 TO 11/4" OPENINGS)
BAG DUST FILTER
AIR DUCT
DUST LADENED AIR
CRUSHERS: CONE OR OTHER GYRATORY TYPE, HAMMER MILLS (INCLUDES HAZEMAG)
FLOATS
CYCLONE COLLECTORS
TROMMEL DUSTING & GRADING
SCREENS -20 MESH
COLLECTORS
+20 MESH
SCREENS -20 MESH
FINE SCREENING
FINE SCREENING
LONG FIBER CONC.
MEDIUM FIBER CONC.
SHORT FIBER CONC.
CRUSHERS OR FIBERIZERS: CONE, GYRODISC, HORIZONTAL OR VERTICAL HAMMER MILLS
ATTRITION MILLS
PULVERIZERS
COLLECTORS
AIR CLASSIFIER
REJECTS
REJECTS
AIR CLASSIFIERS
FLOAT FIBER GRADES
SPECIAL FLOAT GRADES
FIBERIZING-SCREENING STAGE REPEATED ONE TO THREE TIMES
COLLECTORS
PACKAGING
PACKAGING
OVERS FROM LAST-STAGE SCREENS ONLY
SCREENS
SCREENS
SCREENS
COLLECTORS
COLLECTORS
SCREENS
TROMMELS (GRADERS OR DUSTERS)
COLLECTORS
COLLECTORS
REFUSE ELIMINATION MACHINES
TROMMEL (GRADERS OR DUSTERS)
FIBER OPENING EQUIPMENT
FIBER OPENING EQUIPMENT
DUSTING AND FIBERIZING EQUIPMENT
DUSTING AND FIBERIZING EQUIPMENT
TROMMELS (GRADERS OR DUSTERS)
DUSTERS
SCREENS
SCREENS
SCREENS
SCREENS
COLLECTORS
COLLECTORS
COLLECTORS
COLLECTORS
3-GROUP FIBER GRADES
4-GROUP FIBER GRADES
5&6-GROUP FIBER GRADES
7-GROUP FIBER GRADES

PART I

GENERAL

PART I

1.0 OFFICERS OF UNITED ASBESTOS INC.

(1) P. Malouf - Chairman of the Board

(2) R. J. Merrill - President

(3) M. L. Pouliot - Vice - President

(4) H. F. Plate - Vice - President

(5) D. C. Cook - Mine Manager (1)

(6) J. S. Rogers - Mine Manager (2)

(7) J. J. Forbes - Mill Manager

(8) J. Hagan - Pit Superintendent

UNITED ASBESTOS INCORPORATED

1.1 Certificates of Approval that have been issued to United Asbestos Incorporated to-date are:

1) A Certificate of Approval Air Application #64/5/63 dated July 9, 1975, for United Asbestos for the approval of the construction of an asbestos mining and milling operation with the capacity of 4,000 tons per day including bag filter controls on the following: secondary crusher 53,000 acfm, mill building 450,000 acfm, ore storage 17,000 acfm, ore dryer 60,000 acfm, and a 9,000 acfm cyclone on the primary crusher.

2) Certificate #4/001/75-006 - Sewage Works Approval issued to United Asbestos Incorporated for the installation of a waste water control and disposal system. The United Asbestos mine near Matachewan designated to limit the discharge of asbestos fibres to the natural environment consisting of a) facilities to recycle mill process water to the tailings pug mill - b) distribution system for the discharge of excess process water to the swamp area south of the mill - c) a water reclaimed area at the north east arm of Lloyd Lake and two reclaim ponds 1) impermeable designated no. #4 and 1 permeable designated no. #3 - d) decant structures for both dams.

e) all pumps etc. with an ultimate effluent discharge to Lloyd Lake all in accordance with the application dated December 18, 1974 dated in Toronto on July 8, 1975.

3) Permit to take water; there are two; 75-P-5012 and 75-P-5013. These authorized the withdrawal of water from Lloyd Lake in accordance with the stated terms and conditions. The permits are valid until March 31, 1980.

4) Application # 7104204 for the Approval of a Waste Disposal Site tailings pile and waste rock from the mining and milling of asbestos ore. Total area of approximately 2600 acres and the area to be utilized for the waste would be 250 acres.

5) Application # 8-5063-76-776 dated January 27, 1977 - approval for the installation of 1 No. 6 oil fired link belt model 1106/42 roto louvre dryer system vented by a 70 foot high stack 10 feet above roof. Input 35,000 BTU/hr.

6) Application # 8-5020-76-006 dated June 16, 1976 for the installation of model 168 size 1220 wheelabrator filter bag collector on the crusher building ventilation with a capacity of 10,600 cfm discharged at height of 23 feet above grade. This is located at the primary crushing building.

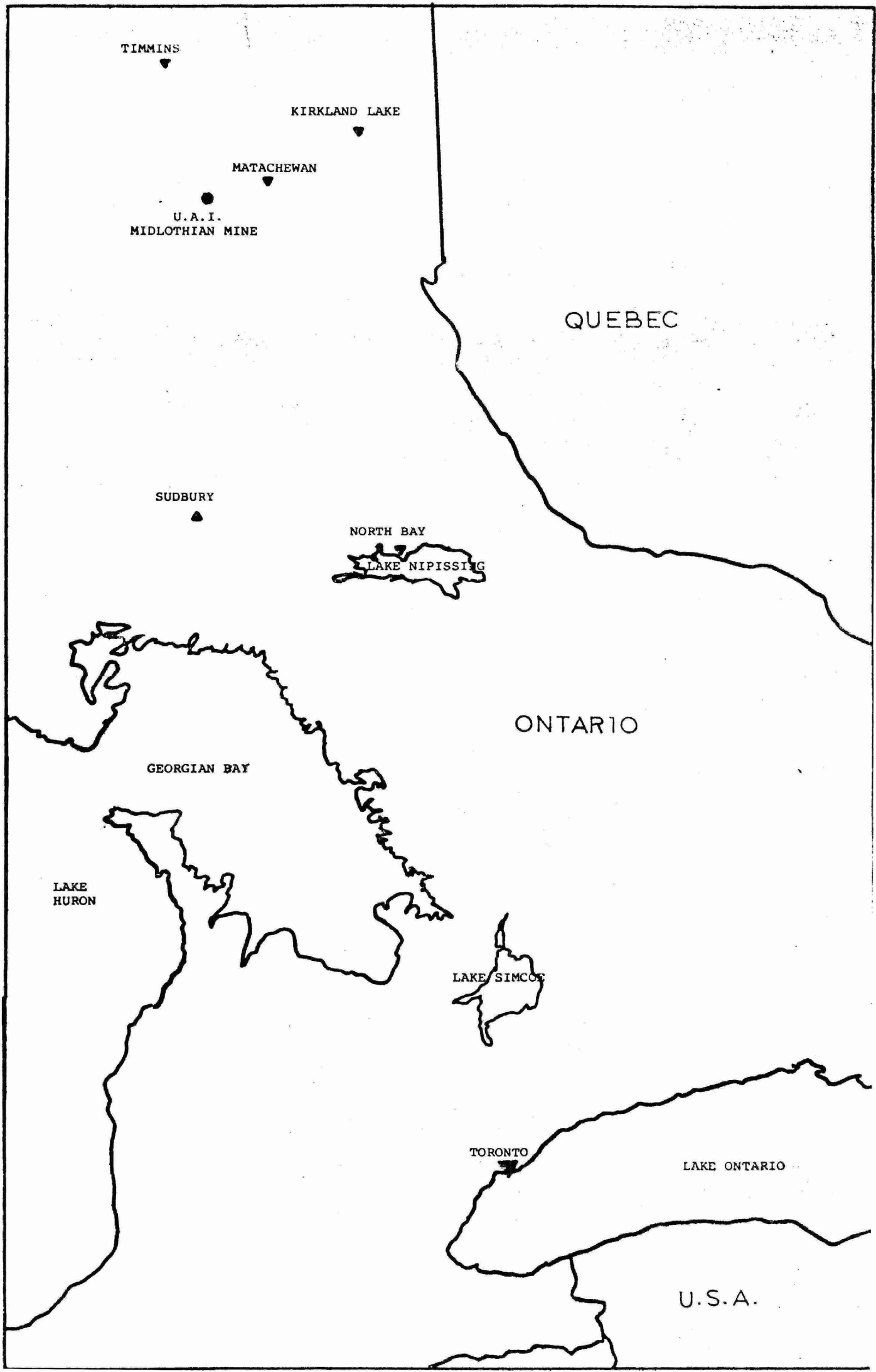
7) Application # 85064-76-776 dated January 27, 1977 for the installation of a wheelabrator model 168 size 1622-D shaker type dust collection system. With a volume of 60,000 cfm., a cloth ratio of 2:3 and discharged at a height of approximately 75 feet above grade.

8) Provisional Certificate of Approval Waste Disposal Site 2600' west of Duncan Creek, Township of Doon.
A-7041101 March 36/76 Expire June 30/80.

1.2 GENERAL HISTORY

The initial claims near Lloyd Lake were staked in the mid 1930's when gold was discovered near Midlothian Lake, Davidson Lake etc. When it was found that asbestos was more important than gold additional ground was staked in the area. Various companies amalgamated and dissolved and by 1970 ownership of the total claim area had been purchased by United Asbestos Corporation which later, by merging in 1973 with Asbestos Lloyd Mines Ltd. and Allied Mining Corporation, became United Asbestos Incorporated.

To-date the Company has the rights to approximately 70 claims (2554 acres).
See map of Ontario on page 16.

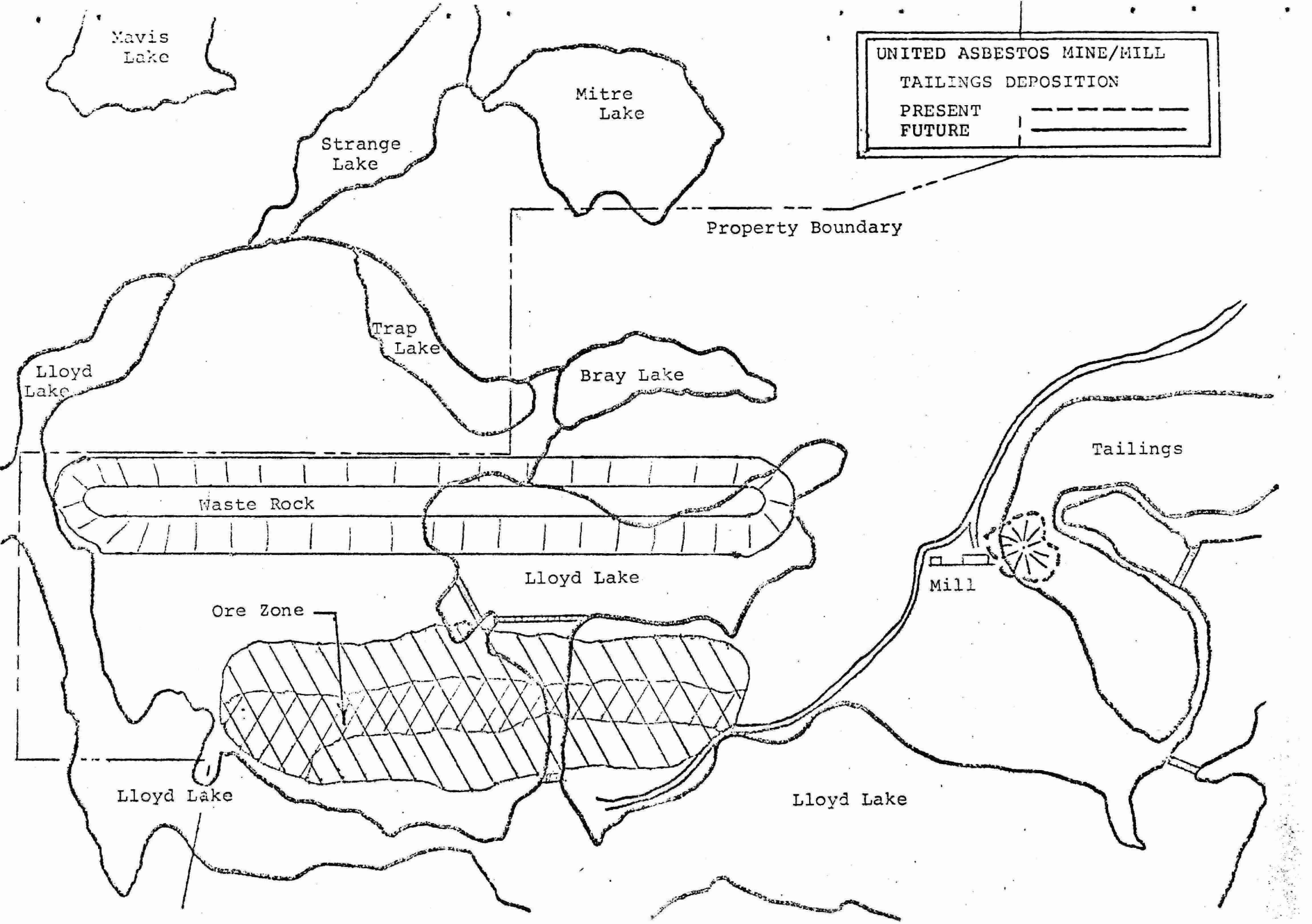

TIMMINS
KIRKLAND LAKE
MATACHEWAN
U.A.I.
MIDLOTHIAN MINE
QUEBEC
SUDBURY
NORTH BAY
LAKE NIPISSING
ONTARIO
GEORGIAN BAY
LAKE
HURON
LAKE SIMCOE
TORONTO
LAKE ONTARIO
U.S.A.

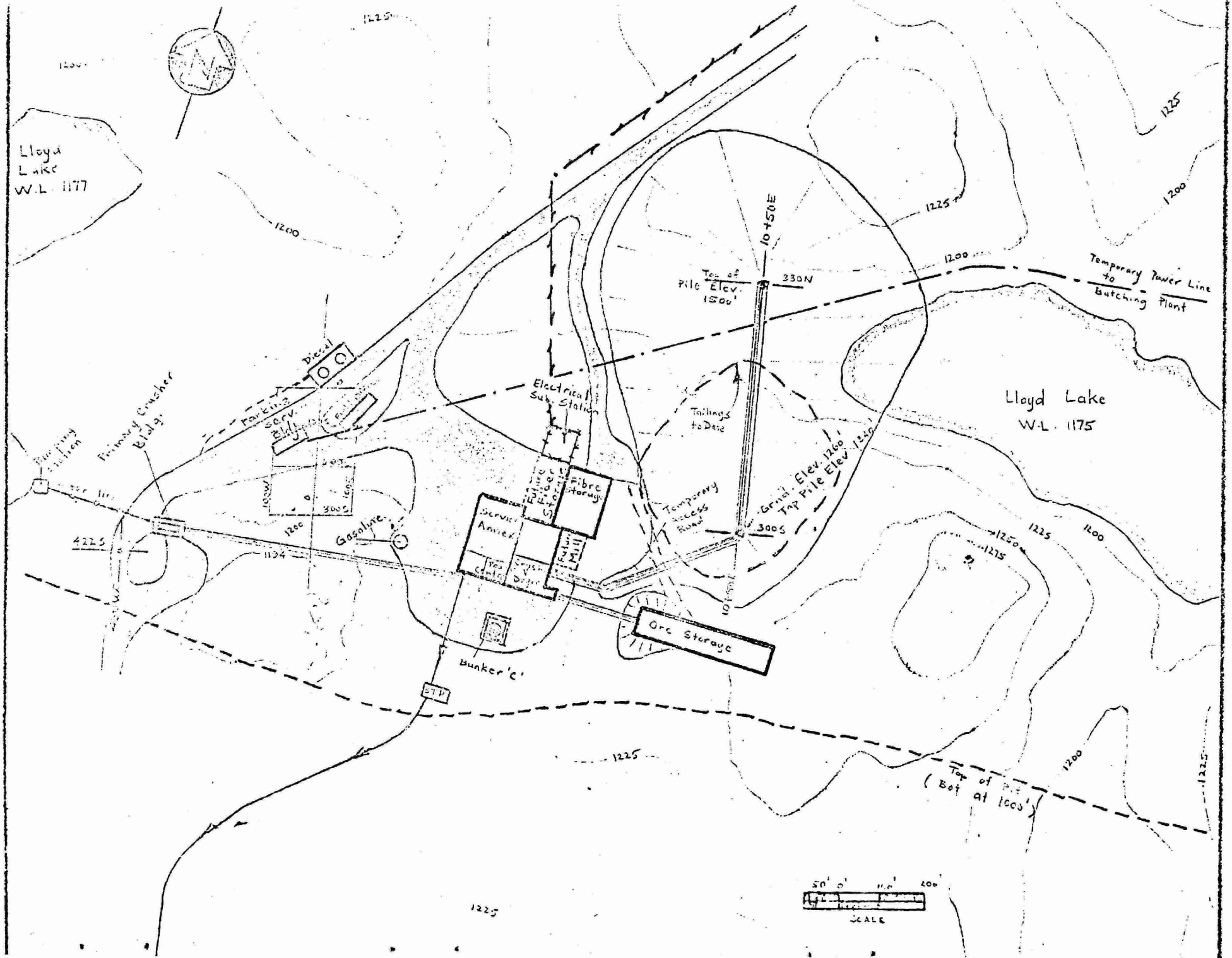
LOCATION

The location of the chrysotile deposit lies approximately 17 miles west of the Town of Matachewan in the District of Timiskaming (three miles due east of the Timiskaming - Sudbury boundary line). The latitude of the orebody and longitude is 47°-52' and 81°-00' respectively. The basic shape of the orebody is somewhat oblong and has an east-west length of 5000' with the north-south average width of between 150' to 200'. The average depth of orebody 425'. A remarkable point concerning the initial orebody is in the fact that approximately 1/20 is under the causeway which divides Lloyd Lake; the north central arm from the south section of the north central arm (refer to: 1) United Asbestos mine/mill tailings deposition page 19, and 2) United Asbestos Inc. Midlothian Mine water diversion proposal page 72). Presumably after a 25 yr. period when the company increases the pit area, an even larger proportion of the orebody will lie under Lloyd Lake, just how much cannot be answered at this time.

Up-to-date removal of overburden (depth approximately 8'-10') and ore has basically taken place east of the causeway (width approximately 200').

The face has been cut to a depth of roughly 100' from the original elevation of 1300'. The elevation of Lloyd Lake at the south section of the north central arm is 1175'. Estimated tonnages from this orebody is in the neighbourhood of 2.5 x 10^6 tons of marketable fibre in 33 x 10^6 tons of rock, leaving 47 x 10^6 tons as waste.


UNITED ASBESTOS MINE/MILL
TAILINGS DEPOSITION
PRESENT
FUTURE
Mavis Lake
Mitre Lake
Strange Lake
Property Boundary
Trap Lake
Lloyd Lake
Bray Lake
Tailings
Waste Rock
Lloyd Lake
Mill
Ore Zone
Lloyd Lake
Lloyd Lake


Lloyd Lake W.L. 1177
1225
1200
10+50E
330N
Top of Pile Elev. 1500'
Temporary Power Line to Batching Plant
Lloyd Lake W.L. 1175
Electrical Sub. Station
Tailings to Dam
Diesel
Service Bldg.
Primary Crusher Bldg.
Fibre Storage
Service Annex
Temporary Access Road
Gasoline
Grad. Elev. 1260
Top Pile Elev. 1240
300S
Ore Storage
Bunker 'C'
STP
4225
1194
Top of Pile (Bot at 1000')
SCALE

UNITED ASBESTOS INC. MINE-GEOLOGY

The chrysotile asbestos is associated with peridotite and serpentine with an average grade of 8%. The orebody itself lies in a zone of ultra mafic rock and mafic intrusive rock. To the north west, and south of the ore zone lie intermediate and mafic metavolcanics and felsic metavolcanics. To the east almost adjacent to the body lies the Cobalt group comprised of argillite; conglomerate; and greywacke, quartzite, arkose.

At the end of 25 years the waste rock dump will occupy an area of 110 acres and will be located north of the ore zone. The north central section of Lloyd Lake will undoubtedly be dewatered mainly because of (1) safety factors concerning the establishment of an open pit and (2) eventually the north section of the central north bay will be utilized for rock storage. Because of the foregoing, water for the mill i.e. cooling, etc. will have to come from other sections of Lloyd Lake.

1.3 GENERAL PROCESS DESCRIPTION MINE

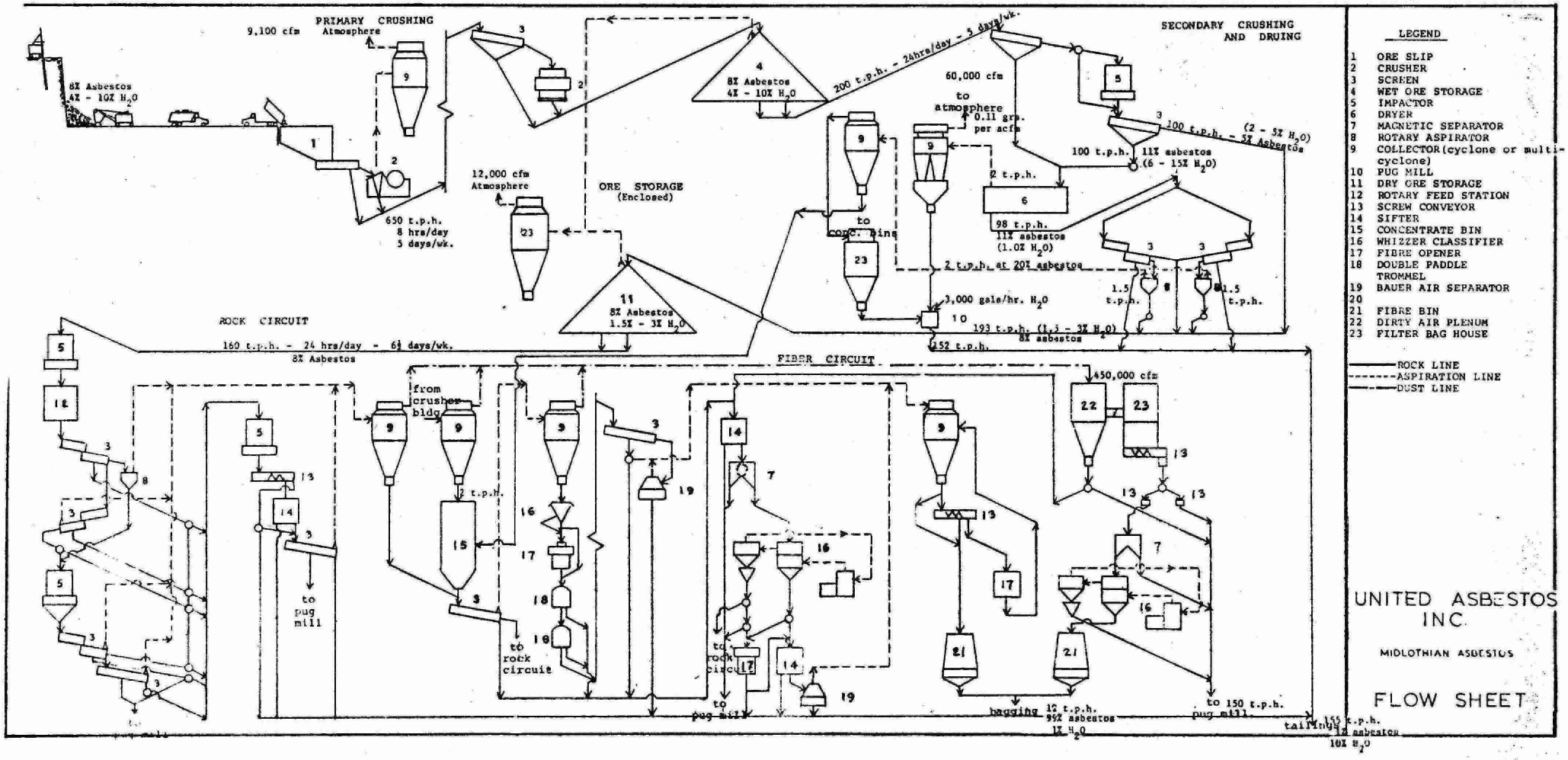
The mine operated 24 hrs./day, 6 days/week with three (3) conventional shifts. Two or three track drills were utilized at the ore zone and operate on roughly 1200 cfm (33.98 m^3/min) of compressed air with a tramming speed of 150 fpm (45.72 m/min). These were used for blast hole drilling. Dry-type dust collectors were used to protect equipment, and the health of the operators. As the drilling proceeds, venturi action moves rock dust and cuttings into a hopper where centrifugal action separates chips and dust. Fines are collected in filters and the chips drop into a plastic tube which can be tied off into plastic bags, and removed without interruption of the drilling cycle. It is of note here that officials of United Asbestos decided that because of the harsh winter conditions, dry drilling techniques would be utilized instead of wet drilling methods.

Explosives used were of the An-Fo flow type to remove overburden and ore from the zone area.

After being drilled and blasted in the mining operations, the ore was hauled by 30 ton Terex trucks some 1000' away from the ore zone to ore storage area. This area was south and adjacent to the primary crusher. The ore was broken to a maximum of 36" so that the feeder or hopper of the primary crusher (max. capacity 100 tons) would accept it. Please refer to the United Asbestos Inc. Flow Sheet on page 24 . This ore contained an average of 8% chrysotile fibre and had an average moisture content of 5% (actually the moisture content of this ore ranged from 4-10% with an average percentage of moisture for serpentine rock at 5%.

1.4 MILL

The ore leaving the primary jaw crusher was reduced to a fragment with a diameter not larger than 6". Subsequently, this crushed ore was transported via an 800' enclosed 24" conveyor with an operating capacity of 555t/h. The ore at this point, is sized by a 6' x 14' double deck screen which directs rock fragments smaller than 2" to the wet ore storage area (one section for low grade 2800 TC. and the other for high grade 7200 TC). The larger fragments (fragments less than 4" and fragments greater than 2") travel to a 5½' cone crusher to reduce the ore further to 1½", after it joins the main stream to the wet ore storage area.



LEGEND

1 ORE SLIP
2 CRUSHER
3 SCREEN
4 WET ORE STORAGE
5 IMPACTOR
6 DRYER
7 MAGNETIC SEPARATOR
8 ROTARY ASPIRATOR
9 COLLECTOR (cyclone or multi-cyclone)
10 PUG MILL
11 DRY ORE STORAGE
12 ROTARY FEED STATION
13 SCREW CONVEYOR
14 SIFTER
15 CONCENTRATE BIN
16 WHIZZER CLASSIFIER
17 FIBRE OPENER
18 DOUBLE PADDLE TROMMEL
19 BAUER AIR SEPARATOR
20
21 FIBRE BIN
22 DIRTY AIR PLENUM
23 FILTER BAG HOUSE

——— ROCK LINE
------ ASPIRATION LINE
—·—·— DUST LINE

UNITED ASBESTOS INC.

MIDLOTHIAN ASBESTOS

FLOW SHEET

The wet ore from the storage area is extracted by a chute feeder to further double deck screening operations impact crushers etc. Fine ore (less than ½") from the vibrating chute feeder makes its way to either an 80 ton/hr. dryer or if dryer is operating at a maximum capacity at that time, is directed to the triple deck screens (by-passing the stedman mill). The coarser fraction, composed of 1½" diameter to ½" diameter, travels to the Stedman impact crusher and on to the triple deck screens. The underflow (less than ¼") travels to the dryer or to rotary distributor. If it is directed to the rotary distributor it is then conveyed to the coarse tailings line.

Generally speaking, the undersized screenings (less than ¼") form the dry ore storage, which is enclosed to prevent emissions to the exterior environment. All filter aspiration lines from the main tandem screening area (3 lines) are forwarded to pre-cleaning cyclones before entering the main bag filter. The underflow from cyclone goes to the concentrate storage bins or it can be directed to further screening. The fines from the bag filter join the fine tailings line, along with fines from dryer baghouse. To elaborate further, there are two (2) tailings lines in the process.

The fine tailings from the pre-cleaning cyclones and baghouses and a coarse tailings line from the crushing, screening and grading operations.

The dried ore containing the chrysotile asbestos is conveyed to the rock circuit in which its principal purpose is to further separate entrained fibres from the co-existing rock. This ore contains 8% chrysotile asbestos and from 1.5% to 3% moisture. The total tonnage directed from dry ore storage to the impactor in the rock circuit is 160 t.p.h./24 hr./ day - 6.5 days/week.

The rock circuit not only separates the fibres from the rock, but attempts to grade them as tertiary crushing and screening techniques are used over and over again. All aspiration lines are directed to 2 of 3 collectors. The underflow being returned to further screening etc. while the overflow is directed to a dirty air plenum, then to the main mill baghouse (45,000 cfm). The purpose of the plenum is to reduce loading to the main mill baghouse. The third collector, not mentioned in the previous paragraph, feeds the concentrator storage area (underflow) at a rate of 2 t.p.h. The input to this collector is from the screening area (i.e. dryer) located in the secondary crushing and dryer circuit.

In the rock circuit area, as mentioned previously, further screening etc. finally takes place to remove all entrained fibre from the rock. The screens are equipped with air aspiration hoods that facilitate separation in the air stream. In this circuit the clean rock (probably containing 1% chrysotile fibre) is either directed to the coarse or fine tailings lines. The aspiration system (i.e. cleaners) is vented to the dirty air plenum and then to the main mill baghouse. The fibres in this circuit have been roughly graded to long, medium and short lengths. The fibre circuit at United Asbestos Mine performs additional fibre opening, separating opened fibres from unopened substances and classification of fibres. Double paddle trommels and a Bauer Air Separator combine undersized fibres with short fibres from the rock circuit and the oversized fibres are air aspirated for further grading. All fibres transverse to various grading processes (i.e. grading cyclones) where spinning fibres, paper stock, shingle and short fibres are separated. All aspirating lines or discharges from cyclones flow into the dirty air plenum which in-turn is connected to the main mill baghouse. The six Bauer Air Separators reject some waste material to the tailings conveyor.

Different grades of chrysotile fibres from eight(8) 1200 ft.^{3} capacity silos are packaged either by pressure packaging or by blowing material into containers (the following page tables the Canadian Asbestos Classifications). The product is either bagged or sealed into large containers for road delivery to southern Ontario or foreign markets.

CANADIAN CHRYSOTILE CLASSIFICATION

Group No. 1 - No. 1 Crude - cross-fibre veins having 3/4 inch staple and longer

Group No. 2 - No. 2 Crude - cross-fibre veins having 3/8 inch staple up to 3/4 inch.

Run-of-mine Crude - consists of unsorted crudes.

Sundry Crudes - consist of crudes other than above specified.

Group No. 3 - (Commonly referred to as textile or spinning fibres)

3D
3F
3K
3R
3T
3Z

Group No. 4 - (Commonly referred to as shingle or asbestos cement fibres)

4D
4H
4J
4K
4M
4R
4T
4Z

Group No. 5 - (Often referred to as paper stock grades but also considered as short shingle fibres)

5D
5K
5M
5R

Group No. 6 - (Waste, stucco, or plaster fibre)

6D

Group No. 7 - (Shorts)

7D
7F
7H
7K
7M
7R
7T
7RF and 7TF Floats
7W

Group No. 8 - (Sand)

8S under fifty pounds per cubic foot loose measure

8T under seventy-five pounds per cubic foot loose measure

Group No. 9 - (Gravel and stone)

9T over seventy-five pounds per cubic foot loose measure

The Pug Mill at United Asbestos mine/mill complex is the last section of the process that will be commented on. This section of the mill is located adjacent to the main tailings conveyor that leaves the mill building to the tailings area. In essence, the pug mill in conjunction with a weightometer adds water to the fine tailings fraction before it leaves the mill building. When United Asbestos Inc. was in operation, 15 gal/min. of water was used when the tailings discharge was in the range of 80 tons/hr.

PART II

MINING

PART II

ENVIRONMENTAL CONCERNS OF UNITED ASBESTOS INC.

MIDLOTHIAN TOWNSHIP

SECTION - MINING

2.0 The mining operations encountered at the Midlothian Mine gave rise to a number of emission sources that were aggrevated by meteorlogical conditions and the topography of the immediate area.

2.1 The removal of overburden by earth moving equipment did generate emissions of both asbestos dust and matrix dust to the surrounding environment. Conveying waste overburden to suitable site locations for levelling purposes and for road building by enormous sized trucks added to emissions near the proposed pit area.

2.2 After the orebody was exposed, primary blasting was carried out to break-up the massive deposits of chrysotile asbestos-bearing rock. This in turn caused huge clouds of dust that settled primary south of the proposed dam #1 on Lloyd Lake (the prevailing winds are from the north-west).

It has been noted, that on a number of visits to the complex in the winter months, large pieces of ore and overburden were seen on the ice, some 1500' from the ore zone. This indicates the magnitude of the detonations.

2.3 Secondary blasting basically involved reducing the ore so that the ore slip at the primary jaw crusher could accommodate the ore. Because of the immediate topography of the area and meteorological conditions experienced to date, high levels of chrysotile asbestos in the atmosphere have been discovered some 2000' north-east of the eastern sector of the ore zone near the transmission tower hill (elevation 1250'). The hill is roughly 75' above the north central section of Lloyd Lake. It is suggested that although the primary crusher (i.e. loading slip) does account for some loadings to the air, perhaps there is a channelling wind effect within the surrounding area, especially in the north-eastern direction where an expectionally high level of asbestos occurred in August/76 (Total fibres/CC = 4.58: Fibres greater than 5 um/CC = 0.14).

PART II

MILLING

PART II

2.0 MILLING

The milling of asbestos ore by the conventional dry process requires extensive handling etc. of the material. Thus, there are numerous potential sources of asbestos emissions at the facility for milling.

2.1 The deposition of ore (36") into the 100 ton ore slip for primary crushing releases asbestos dust etc. to the ambient air. Even though it had been claimed that the ore was fairly high in moisture content, dust from roadways adhering to the ore can generate emissions when dumped into the ore slip. Recently, United Asbestos Inc. made a submission to the Ontario Government and received approval for a bag filter (10,600 cfm) on the primary crusher building. This application was dated on June 16, 1976. This baghouse was installed to remove emissions from the ore slip (previously a cyclone was utilized with low efficiency). See page 14.

2.2 The secondary crushing and drying area of the mill was a cause of air emissions at the Midlothian Mine. Severe fracturing of the rock by secondary crushing freed additional asbestos fibres from the ores. The rotating mixing action of the cone crusher increases emissions to the interior environment. The need for feed and exit ports existed and must be provided with the crushers, which facilitates emissions to the exterior environment. The emissions will undoubtedly increase as the housekeeping in the mill area decreases.

The roto louvre rotary dryer (No. 1) was equipped with a four compartment shaker bag filter (60,000 acfm). Concentrations of SO_2 emitted from the dryer was calculated at 0.06 ug/ml at the property line, well below the standard of 0.25 ug/ml,(.5 hr.).

During the operation of the United Asbestos Midlothian Mine, the No. 1 dryer did not run at the full capacity of 80 ton/hr. Therefore emissions were not a significant problem from this piece of equipment during that time.

2.3 In the rock circuit area, the separating of fibres from the ore required large volume of air (air aspiration) which were directed to fabric filters. Since make-up air was drawn into the mill building to replace the exhausted air, the building was frequently under negative pressures. When the volume of air exhausted was greater than the make-up air coming in, asbestos emissions to the atmosphere increased.

This was observed at the Midlothian Mine where visible emissions from open doors, vents etc. occurred quite frequently. These fugitive emissions were undoubtedly hard to trace down, perhaps as an interim measure more attention should have been placed on housekeeping near the screening and impact mill areas of the mill.

The vibratory motion of the grading screens to size the ore (4" down to ¼") was yet another possible area where internal emissions were evident. Much of this area including the concentrate bins were aspirated to the main mill dirty air plenum. This plenum was installed to take the loading from the main mill baghouse that was located on the top floor of the mill.

This baghouse had a capacity of 450,000 cfm. The fines from the dirty air plenum joined the fine tailings stream for pugging before leaving the mill building.

2.4 In the fibre circuit, as previously mentioned, the grading of fibres is accomplished by the use of cyclones. The cyclones were connected into the main aspiration lines throughout the fibre circuit in the mill. Emissions to the internal environment can occur when the loadings are increased to classifiers, conveyors etc. and trommels. After the mill was ordered closed by the Ministry of Natural Resources in 1976 for high internal asbestos counts, management added numerous cyclones in the fibre circuit. These cyclones not only reduced internal emissions, but also decreased asbestos fibre loadings to the tailings area. These cyclones also decreased loadings to the main mill baghouse.

In summation, emissions to the internal environment were quite frequent in the grading circuit where the separation of fibres into numerous standard grades took place. The grading machines open up fibres releasing shorter ones. Screening, grading, and air aspiration lines gave rise to asbestos dust on or around the equipment.

If the housekeeping in the mill was ineffective, then eventually, release of dust to the ambient air occurred by either overloading of the dust control equipment or dust escaping from conveyors, shakers etc. that were located in the mill building.

2.5 The bagging circuit of the asbestos mill was a possible source of asbestos dust emissions.

It is here where four hydraulic pressure packers force certain grade of fibres (grades #5, 6, and #7 with some #4) into plastic containers for shipping. (see page 29). Housekeeping was important in this area mainly because of the location (open to the atmosphere i.e. loading dock). Cyclones from air aspiration lines (from fibre circuit) drop the grades of asbestos on either a screw conveyor or fibre bins with a 1200 $ft.^3$ capacity. Unless these conveyors are covered eventual emissions could occur to the atmosphere.

2.6 In the later part of 1975., H. Fiset and Sons, a haulage contractor from the Elk Lake area, was contracted by United Asbestos Inc. to haul their chrysotile asbestos product from the mine/mill complex.

The product was either packaged in 20 ton containers or bagged separately in 100 lbs. plastic containers. (Ninety-five percent of the product was weighed in at 100 lbs./container; five percent of the product was weighed at 80 lbs./container). If the product was sent to overseas buyers or if it was forwarded to customers in the United States, 20 ton containers were used (i.e. 2 per truck). If, on the other hand asbestos was directed into the Toronto - Hamilton core, 33 ton pallets were used.

Continuous, shipping of graded chrysotile asbestos (approximately 250 tons/week) commenced April/76 and ended March/77 (closure). Therefore the tonnage of graded fibre leaving the complex for almost one year was estimated at 13×10^3 tons.

Environmental problems associated with haulage of the product, whether in sealed containers or bagged, from the mine/mill complex to the Town of Matachewan on a rough secondary road, appeared to be minimal.

No environmental problems occurred as a result of hauling from Matachewan to the main northern Ontario artery Highway #11.

In summation of Sections I and II in dealing with seven (7) general source locations - i.e. mining, loading, hauling, unloading, crushing and drying, milling and tailings; I find that perhaps United Asbestos Inc. did not, at any degree, utilize the best practicable control technology currently available (BPCTCA) or as a matter of fact the best available technology economically achievable (BATEA) to reduce aerial emissions from their mine/mill complex when operating.

PART III

AIR QUALITY

PART III

AIR QUALITY - UNITED ASBESTOS INC.

3.0 Since ability of correlating quantitative analytical techniques and sampling procedures for the determination of airborne asbestos in the atmosphere was still in the infant stages in 1974-1975., the Ontario Ministry of the Environment utilized a number of laboratories for asbestos analysis.

The procedures for the techniques were long, tedious and costly. With such a large number of samples to process, many laboratories (i.e. Ontario Research Foundation - Dr. E. J. Charfield and McMaster University - Dr. J. R. Kramer) were quite tardy in returning results to the appropriate agency concerned.

Another fact related to the sampling and analysis was that at the time, laboratories could not totally agree on a standard analytical technique for the determination of asbestos in the atmosphere.

Thus the following analytical asbestos results pertaining to airborne asbestos must be viewed as indicators of a certain location rather than positive precise measurements of fibres in ambient air.

3.1 The ambient air asbestos standards for Ontario are:
1) 5 ug/m^3 averaged over 30 minutes. This is an interim guideline based on a total fibre count and is a calculated amount on dispersion, not a measured amount.
2) 0.04 fibres/cm^3 (greater than 5 um in length) averaged over 24 hrs. This is a criteria objective and is based on a measured amount. The above does not apply to a sampling period less than 24 hrs.

For comparison sake two ambient air standards south of the border are listed.
1) California - Total fibre count downwind of an asbestos emission source must not exceed 10 times the total fibre count upwind of that source.
2) Connecticut - 30 ng/m^3 (based on a 30 - day average sample).

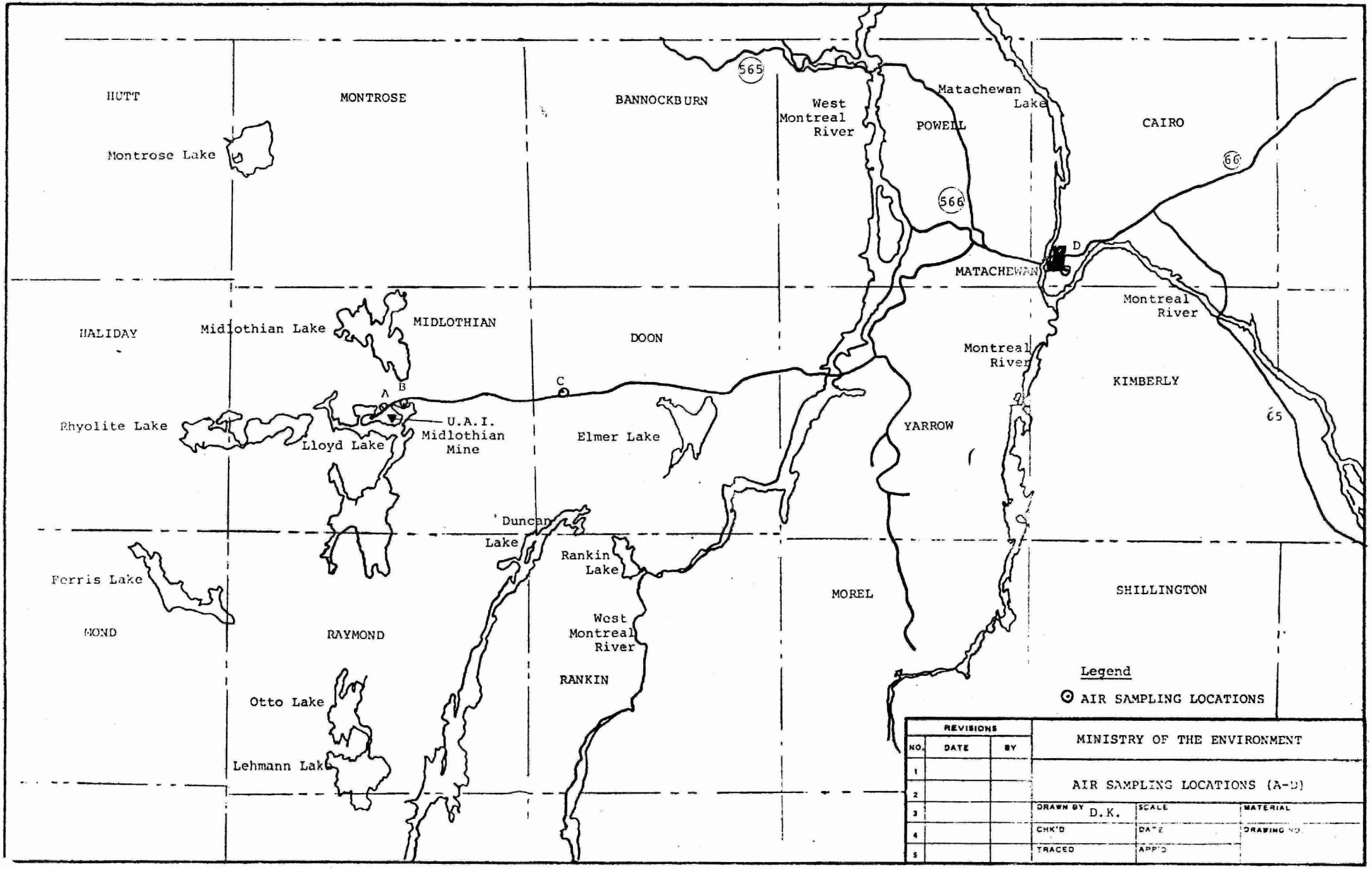
3.2 In dealing with the proposed United Asbestos Midlothian Mine/mill complex near Matachewan in early 1975, the Air Resources Branch of the Ontario Ministry of the Environment welcomed the chance to monitor the area before the complex went on stream.

In March of 1975 when the overburden was being removed, personnel from the Ontario Ministry of the Environment, Toronto established two locations for high-volume asbestos sampling using a modified high-volume sampling apparatus and special portable filter head cartridge (These cartridges were used so that the delicate 8" x 10", 0.4 um pore size Nuclepore sheets could be unloaded and loaded under all controlled conditions).

A total of three (3) samples were taken; two at the labour camp (c) and one at the mine-site (the location was approximately 200' from the primary crusher building). Please refer to Air Sampling Location page 46.

Fibre counts on March 3 and March 6/75 at the labour camp (c) revealed low levels; however, there appeared high concentrations of total fibres in the other category. This presumably was due to activity at the labour camp i.e. installation of septic tank systems etc.

Analysis of chrysotile fibres at the mine/mill site (same month) revealed a slightly higher concentration of total fibres and were almost totally chrysotile in nature. This observation according to the Air Resources Branch and the fact that there was a chrysotile bundle (5 fibres equal to or greater than 5 um) and a longer average length of fibre than in the other samples, suggested that the blasting of overburden may have been responsible for the sudden increase in ambient levels of chrysotile fibre.


HUTT
MONTROSE
BANNOCKBURN
West Montreal River
Matachewan Lake
POWELL
CAIRO
565
566
66
Montrose Lake
D
MATACHEWAN
Montreal River
HALIDAY
Midlothian Lake
MIDLOTHIAN
DOON
Montreal River
KIMBERLY
C
A
B
Rhyolite Lake
U.A.I. Midlothian Mine
Lloyd Lake
Elmer Lake
YARROW
65
Duncan Lake
Rankin Lake
Ferris Lake
MOREL
SHILLINGTON
MOND
RAYMOND
West Montreal River
RANKIN
Otto Lake
Lehmann Lake
Legend
AIR SAMPLING LOCATIONS
REVISIONS
NO.
DATE
BY
MINISTRY OF THE ENVIRONMENT
AIR SAMPLING LOCATIONS (A-D)
DRAWN BY D.K.
SCALE
MATERIAL
CHK'D
DATE
DRAWING NO.
TRACED
APP'D

In early October 1975, the Air Management Branch selected the mine/mill complex for their No. 1 sampling location. As the operations were already underway, it was felt that down wind from the ore-body would be a logical place to sample. However, because of the gross emissions (mostly from primary and secondary blasting) experienced at the site the Nuclepore filter sheets that were used were weighed instead of utilizing electron micros-copy techniques.

The 2nd location near the labour camp (4.2 miles from mine/mill site) was again sampled by the Air Management Branch on October 8, 1975.

The duration of sampling was seven hours and the analysis from Dr. J. R. Kramer indicated a total fibre count of 20 fibres/cm^3. Of this total quantity, 0.35 fibres/cm^3 were greater than 5 um in length, and of the total mass, 80.6% were chrysotile in nature.

Assuming the remaining seventeen hours (seven hour continuous sample) had a zero count, then the twenty-four hour average of fibres/cm^3 greater than 5 um in length would be 7/14 x 0.35 = 0.102 fibres/cm^3 thus the criterion was exceeded by 2.5 fold increase.

ONTARIO MINISTRY OF THE ENVIRONMENT

AIR SAMPLING RESULTS

Sampling Date	Location	Dist. &Dir. from mill	Total Fibres (fibres/cc)	Fibres > 5u (fibres/cc)	Present of total fibres by category		
					Chry.	Amph	Other
Mar.3/75	Labour Camp (c)	approx.9Km NNE	.116	.002	18	28	52
Mar.6/75	Labour Camp (c)	approx.9km NNE	.210	.004	13	6	79
Mar.13/75	Mine/mill Site (A)	-	.697	.032	96	2	0
Oct./75	Mine/mill Site (A)	-	gross emissions	-	-	-	-
Oct.8/75	Labour Camp (c)	approx.9km NNE	20	0.35 (7 hrs) or 0.10 24 hr.	-	-	-

Please refer to page 46 . Air Sampling Locations

A = transmission tower, B = gravel pit, C = Camp,

D = Matachewan

3.3 Since the Air Management Branch (SS & PP , Technology Development and Appraisal Section) during the course of sampling at United Asbestos Inc. Mine/mill complex (March - Oct./ 75) and general industrial asbestos source sampling throughout Ontario, had developed standard sampling procedures; it was then felt that the Technical Support Section of the Ontario Ministry of the Environment would have, in early 1976., the expertise and equipment budget to formally embark on their own asbestos air/water sampling program with industries in the Northeastern Region.

With the above in mind, a meeting with United Asbestos Inc. and the Ontario Ministry of the Environment was held on January 14, 1976. On the agenda was a proposal from the Ministry to have United Asbestos Inc. install and operate two air sampling stations on a six day cycle. The two locations were the (c) labour camp and at the (A) transmission tower hill (elevation 1250').

THE FOLLOWING TABLE TABULATES THE ANALYTICAL RESULTS FROM THE UNITED ASBESTOS INC. MINE/MILL OPERATION JULY - OCTOBER 1976.

- MINE/MILL SITE - TRANSMISSION TOWER (A)

Sampling Date	Total Fibres (fibres/cc)	Fibres > 5u (fibres/cc)	Percent of Total Fibres/Category Chry.	Amph.	Other
Jul.28/76	.07	.007	100	0	0
Aug.3/76	.176	.007	100	0	0
Aug.23/76	4.58	.14	99	1	0
Sept.4/76	.001	0	100	0	0
Oct. 4/76	.366	.014	100	0	0

- LABOUR CAMP SITE - (Approx. 9km NNE) (c)

Sampling Date	Total Fibres (fibres/cc)	Fibres 5u (fibres/cc)	Percent of Total Fibres/Category Chry.	Amph.	Other
Jul.22/76	.02	.001	100	0	0
Aug.3/76	.003	0	100	0	0
Sept.4/76	.003	0	33	66	0
Oct.4/76	.006	.001	100	0	0

Please refer to page 46 Air Sampling Locations

A = transmission tower, B = gravel pit, C = Camp,

D = Matachewan

The end results were, that because United Asbestos Inc. was slow to purchase and install the sampling equipment and failure to pay the Ontario Research Foundation (ORF) for services rendered, sample collection and asbestos analysis were discontinued from October 1976 to March 1977, when at the later date, the plant closed.

3.4 During a three month period, the Ontario Ministry of the Environment conducted a sampling survey in the Town of Matachewan. The Hi-volume sampler was located on the roof of the St. Jean Boscoe Separate School on Matheson St.

It generally was felt that air quality was needed near the closest population centre from the mine/ mill workings.

The results indicated (that because of the low fibre counts obtained from the survey) that a problem did not exist at that time.

It was noted however, that some amphibole and other types of fibres were present. One possible explanation would be the association of these fibres (e.g. tremolite in the Timmins area) to the country rock in the Matachewan area.

ONTARIO MINISTRY OF THE ENVIRONMENT ANALYTICAL RESULTS (MARCH - MCMASTER: APRIL/JUNE - ONTARIO RESEARCH FOUNDATION

SEPARATE SCHOOL - MATACHEWAN (D)

Sampling Date	Total Fibres (fibres/cc)	Fibres > 5u (fibres/cc)	Percent of Total Fibres/Category Chry.	Amph.	Other
Mar.15/76	.14	0	0	100	0
Mar.16/76	B.D.L.	0	0	0	0
Mar.19/76	.04	0	35	35	29
Mar.3/76	.06	0	84	7	7
April 24/76	.02	-	-	-	-
June 17/76	B.D.L.	0	0	0	0
June 29/76	B.D.L.	0	0	0	0
June 29/76	.02	-	-	-	-

Please refer to page 46 Air Sampling Locations

A = transmission tower, B = gravel pit, C = Camp,

D = Matachewan

The 2nd last survey by the Ontario Ministry of the Environment was conducted in October/77, at the four following locations: transmission tower site (A), gravel pit site (B), labour camp site (C) and the separate school in Matachewan (D).

Note: The gravel pit site (B) was approximately 1.5 miles from mine/mill site, and approximately 0.3 miles from tailings deposition.

ONTARIO MINISTRY OF THE ENVIRONMENT ANALYTICAL RESULTS

Sampling Date	Total Fibres (fibres/cc)	Fibres > 5u (fibres/cc)	Percent of Total Fibres/Category Chry.	Amph.	Other
A - TRANSMISSION TOWER SITE					
Oct.26/76	18	.6	100	0	0
Oct.27/76	1.1	0	100	0.	0
Oct.28/76	0.56	0	100	0	0
Oct.29/76	22	.98	100	0	0
B - GRAVEL PIT SITE					
Oct.26/76	0.55	.01	100	0	0
Oct.27/76	0.44	.007	100	0	0
C - LABOUR CAMP SITE					
Oct.26/76	0.032	.016	100	0	0
Oct.27/76	0.18	.005	98	2	0
Oct.28/76	0.26	.011	100	0	0
Oct.29/76	0.73	.01	100	0	0
D - SEPARATE SCHOOL - MATACHEWAN					
Oct.26/76	0.26	0	100	0	0
Oct.27/76	0.27	0	92	0	0

Please refer to page 46. Air Sampling Locations

A = transmission tower, B = gravel pit, C = camp, D = Matachewan

The analytical results from the Technical Support Section of the Ontario Ministry of the Environment surveys indicated that problems did occur near the mine/mill site when the company was operational.

The high levels in ambient air near the mine/mill site could have been caused by either the activities associated with the proposed open pit area and/or emissions from the primary jaw crusher.

At the time of the surveys conducted by the Air Management Branch, United Asbestos Inc. the main air pollution control device for the primary jaw crusher was a 9000 ACFM cyclone (61/5/63). This may had been a source of emissions because of the poor (according to United Asbestos Management) efficiency. Later, in the summer of 1976., the cyclone was replaced with a Model 168 Wheelabrator Shaker type filter bag collector (10,600 cfm) in anticipation of Federal guidelines.

The final survey by the Technical Support Section of the Ontario Ministry of the Environment was scheduled from July 5 - 7/77 and August 16, 17/77. Although the results have not, at the time of this report, been documented, indications are, however, that the levels are close to, or below, the detection limits.

In summation, it can be concluded that since cessation of the mining/milling operations, the concentrations of asbestos (levels) has been reduced to levels slightly above background, and that concentrations of chrysotile fibre decreases with distant travelled from the United Asbestos Inc. mine/mill complex.

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PART IV

AIR QUALITY CONTINUED

PART IV - AIR QUALITY COND'T

TAILINGS AND PUG MILL - UNITED ASBESTOS INC.

4.0 Tailings from the United Asbestos Inc. mill had consisted of floats from the main mill baghouse, fine serpentine dust from fibre cleaning operations (i.e. cyclones), fine undersize screenings from the rock circuits, oversized material from the screens in the rock circuit, and coarse rock rejects from initial upgrading of the ore during crushing. These products contained a certain amount of free fibre; however, the most troublesome products were the floats from the main mill baghouse.

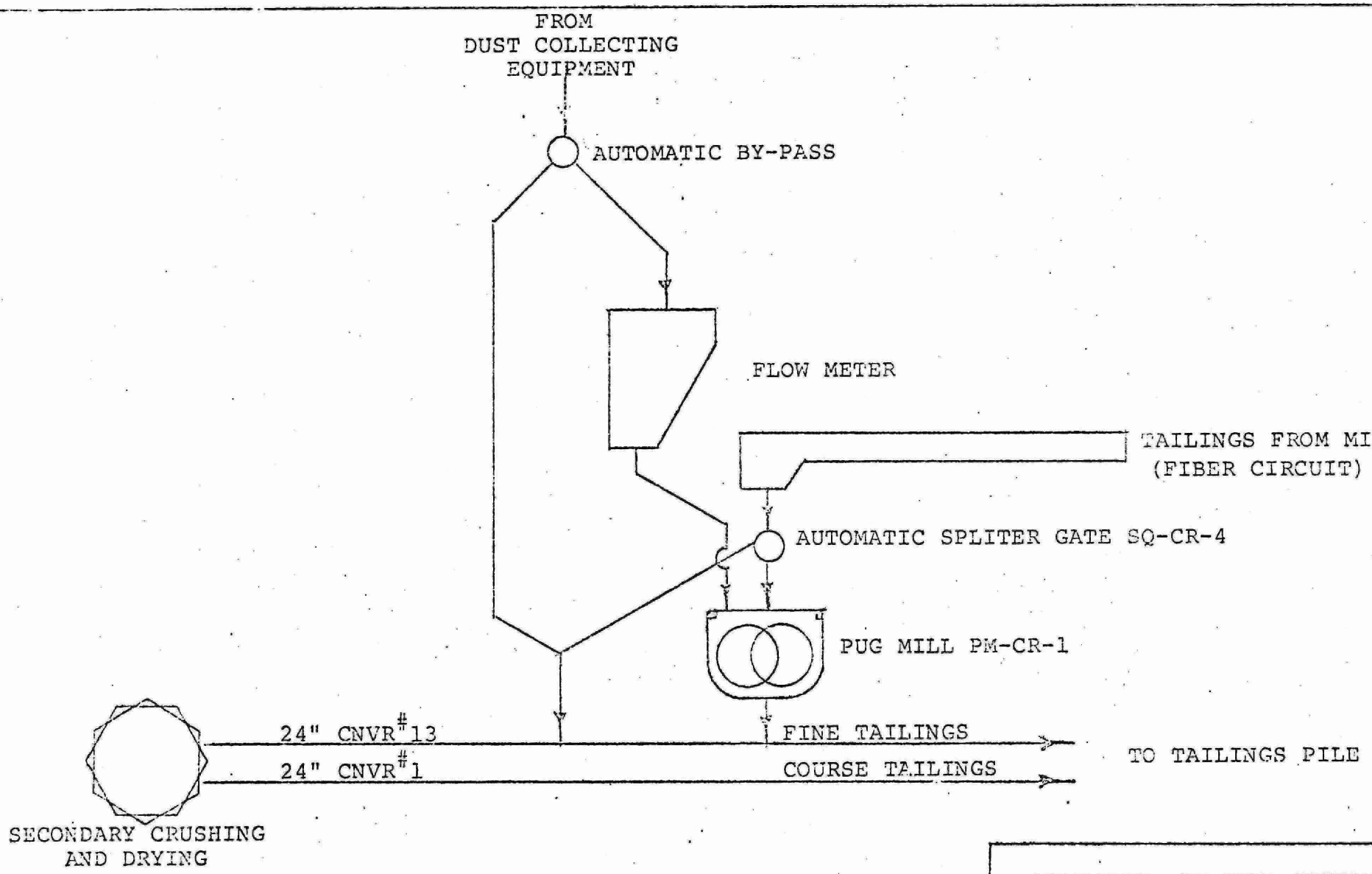
United Asbestos Inc. operated two (2) 24" conveyor belts to transport both fine and coarse tailings to the dump area. (see crushing and drying flow sheet page 60). The coarse belt transports ¼" to 3/8" rejects for deposition; however, the fine belt is used for fine rejects from the crushing and drying area, dust collection equipment and material from the mill fibre circuit.

It is at this time it is worthy to note that at this particular mine/mill complex the floats from the main mill baghouse could by-pass the pug mill if the mill experienced mechanical problems. The pug mill during the life of the mine/mill complex experienced many mechanical problems. The pug mill was designated to operate (before installation of a weightometer) by wetting all floats and dust from the main mill baghouse before joining the fine, medium, and coarse tailings fraction on the coarse tailings line. Fifteen gal/min. of water were to be added when 80 tons/hr. tailings were being rejected. Because of the fluctuations in the milling process (i.e. fluctuations in quantity of tailings leaving the mill), the fine floats were either over wetted or under wetted. The latter naturally compounded the emission problems near transfer points on the conveyors and at the end drop-off location. In order to alleviate this problem, the Ontario Ministry of the Environment was assured by United Asbestos Inc. officials that a suitable weightometer would be installed promptly. However, this did not proceed as quickly as promised and emissions from the conveyors were quite gross on a number of occasions.

Another problem associated with the pug mill was the difficulties of winter time operation. Accordingly, an estimate of a 20% decrease in water usage could be obtained if a sealant to pug the fine tailings would be utilized in the winter months (Freezing of the water lines to the pug mill was quite frequent and therefore no pugging of tailings occurred).

As mentioned previously, the floats from the main mill baghouse and from the dust collection equipment could under certain conditions by-pass the pug mill. It then became apparent that as long as there was a possibility of by-passing the mill baghouse floats directly to the fine tailings conveyor in the winter months emissions could occur.

If the fine rejects were also added to the pug mill along with the main baghouse floats then there should be a provision made to have the rejects by-pass the system so that pugging of the floats would continue in the winter (an understanding from management was that this was not the case with United Asbestos Inc.).



MINISTRY OF THE ENVIRONMENT

modification of

CRUSHING & DRYING FLOW SHEET

4.1 The fine material from the fibre circuit (approximately minus 30 mesh) and the main mill baghouse floats were pugged and directed to a conveyor, already carrying fine tailings from the crushing and drying circuit. This conveyor joined the coarse conveyor (inside building) and directed the mixed tailings outside for deposition (8.3% moisture).

The main tailings conveyor was encased with a semi-circular hood and inclined at roughly between 10^{o}-15^{o} and extended as required, so that the point of discharge was 15' from the tailings pile. Since there was no dust control equipment on the one transfer point (east of the mill building), tailings had on a numerous occasion spilled (onto the ground below the point of transfer) when sudden tailings surges occurred (leaks in the system).

The tailings being discharged from a 15' drop-off point to the asbestos pile below caused one of the main emission problems with airborne chrysotile asbestos.

The fines from the newly deposited tailings, became readily airborne by local winds; probably more so in this area compared to others because of the topography of the immediate area.

As the tailings height increased and seeked its own degree of repose, the distance from the pile to the conveyor decreased. When this happened, earth moving equipment was called in to level the pile as to minimize the number of times the conveyor was to be relocated. This was a secondary emission source. To explain further; not only were the problems of the newly deposited fines being transported by the wind, but also older fines, which incidentally agglomerated into a relatively inert mass, becoming airborne when disturbed and broken by earth-moving equipment.

4.2 To summarize briefly this section on tailings deposition and the pug mill, the following recommendations are offered if a dry tailings disposal is used.

a) the use of an inverted funnel on the dumping section of the main tailings line is needed to curtail emissions at the point of deposition. This funnel should be located as close to the pile as possible.

b) All conveyors leading to the exterior environment should be totally enclosed as to prevent aerial emissions.

c) All tailings should be kept away from all natural water sources (i.e. leaching and run-off problems).

d) Conventional conveyors should be utilized when possible i.e. no high speed stackers.

e) Tailings must be conditioned before conveyance to tailings pile i.e. bag floats pugged.

f) Necessary air collection equipment should be utilized at all transfer points.

g) If the standard tailings deposition is not utilized, then the sector tailings methodology briefly described on the next page, can be used.

In this technique, the mine ore reserves and mill efficiencies etc. are calculated so that one may be able to determine the number of acre-ft. that will be utilized for the tailings deposition (this area will be used for the life of the mine). It is then, that the mine will convey tailings to the farthest point away from the mill. When a section is filled and graded so that emissions will be minimized, the end of the conveyor is dismantled and another section is started. The benefit of the above would be that a section of the total future tailings area would be available for reclamation and stabilization techniques when the mine is still in operation.

PART V

WATER QUALITY

PART V

WATER QUALITY - UNITED ASBESTOS INC.

5.0 Knowing that long exposure to large amounts of asbestos fibres in the air in and around asbestos industries has resulted in an increased incidence of lung cancer, there has been an understandable concern over the findings of asbestos in potable water.

This has lately come to life in the United States where Reserve Mining in Duluth Minnesota has been required by the U.S. Supreme Court to refrain from dumping asbestos tailings (cummingtonite asbestos - not to be confused with chrysotile asbestos) into Lake Superior from their Silver Bay operations.

Levels of asbestos near the Duluth area have been reported up to 87.0×10^6 fibres/l. and higher levels of 172×10^6 fibres/l. near the Town of Thetford Quebec have been found.

Since the background levels of asbestos fibres vary from location to location, the Ontario Ministry of the Environment had stated in December 1974 that the average background levels for drinking water

might be taken as 3×10^6 fibres/l. and for surface water and industrial effluents a somewhat higher level of 5×10^6 fibres/l. may be taken. In dealing with the United Asbestos Inc. mine/mill complex in Midlothian Township, background levels in November 1974 prior to start-up indicated levels of approximately 1×10^6 fibres/l. Thus having difficulty in legally enforcing this type of control without definite standards, it became apparent for the Ontario Ministry of the Environment that an average background level of 3×10^6 fibres/l. drinking water objective would be used for the company along with a 5×10^6 fibres/l. surface water industrial objective. The latter figure would be the upper limit for asbestos concentrations permitted in water.

To legally enforce this type of control, the Ontario Ministry of the Environment would have to rely on the Environmental Appeal Board or Public Hearings.

Because of the many techniques utilized by laboratories across the country for the determination of asbestiform material in water, and because of the fact that the effects to health of asbestos in food and drink are not fully understood, one should take the utmost care in the interpretation of analytical results and not over emphasize the base of analytical data which is forthcoming in this report.

A greater emphasize should be placed; however, on the magnitude of power of the concentration. An example of this is that 3.2×10^6 fibres/l. could actually be the same as 3.9×10^6 fibres/l. However, 3.2×10^6 fibres/l. is drastically different from 3.2×10^9 fibres/l. It therefore is the magnitude of change that should be noted.

5.1 During the preliminary planning for the United Asbestos undertaking in 1974, it was agreed on by both the Ontario Ministry of the Environment and United Asbestos Inc. officials that along with the proposed dam construction for the projected open pit operations and subsequent waste rock area to prevent asbestiform material from entering the main body of Lloyd Lake;

two dams would have to be added (Refer to United Asbestos Inc. Midlothian Mine - Water Diversion Proposal; Page 72).

Therefore on March 19, 1975, United Asbestos Inc. made the following proposal to the Federal Ministry of Transport in Ottawa.

Accordingly, United Asbestos Inc. wanted to construct seven (7) dams across portions of Lloyd Lake, Township of Midlothian, District of Timiskaming, Province of Ontario. The dams numbered #1, 2, 3, 4, and #5 (noted on map as a number in an enclosed circle) would be constructed with cores of locally obtained clay approximately twenty feet wide at the top with approximately fifteen feet of broken rock on the upstream and downstream faces. The dam #6 would be across an intermittent flow of water out of Bray Lake (North of Lloyd Lake) to Lloyd Lake and would be constructed of stone-filled timber cribs approximately five feet high.

Dam #7 would be constructed of broken rock without a clay core.

Dam #1 would be approximately two hundred feet long, and have a maximum depth of water along its centre line of thirty feet.

Dam #3 would be approximately three hundred feet long (later changed to four hundred and twenty feet) with a maximum water depth of eight feet.

Dam #4 would be approximately seven hundred feet long with a maximum depth of twelve feet.

Dam #5 would be approximately five hundred feet long with maximum depth of fifteen feet.

Dam #6 would be approximately twenty-five feet long with an intermittent flow to a maximum depth of one foot.

Dam #7 would be approximately nine hundred feet long with a maximum depth of fifty feet.

The need, according to United Asbestos Inc. officials, for the dams was to keep the proposed pit dry (safety). This is especially true with dams #1, #2 and #5. Dam #7 is a causeway running east-west across the central north bay of Lloyd Lake. This bay would be later be used as a waste rock dump and the causeway will allow contaminated water to be pumped from the open pit into the western sector of the bay to settle out prior to reaching the potable water and cooling system intake that was to be located on the east side of the above bay.

Because of the close proximity of the tailings deposition, which incidentally will follow the northern shoreline of the north-west bay of the north-east arm of Lloyd Lake, it was felt that there would be a need to construct an impervious dam #4 across the bay and also construct a pervious dam #3 farther south. These dams, in essence, would prevent fibres from migrating south into the main portion of the lake. Dam #4 would have an overflow (sand filter) system and hopefully filter out some portion of the fibres.

As a back-up system, dam #3 would be constructed of rock and sand to act as a filter for the remaining suspended fibres (if any) as the flow proceeds south into the main body.

And finally dam #6 was to be constructed to impede or partially divert the southerly flow from Bray Lake to the north-east Bay of the north-west arm of Lloyd Lake.

The construction of all dams were to be completed by December 1, 1977.


MIDLOTHIAN LAKE
WEARY LAKE
MOVIS LAKE
STRANGE LAKE
MITRE LAKE
TRAP LAKE
BRAY LAKE
PROPOSED TAILINGS
TAILINGS TO DATE
WASTE ROCK
LLOYD LAKE
WATER INTAKE
MILL
LLOYD LAKE
PIT
RHYOLITE LAKE
LLOYD LAKE
LEAMING LAKE
MARSHALL LAKE
LLOYD LAKE
AMOS LAKE
STANLEY ISLAND
UNITED ASBESTOS INC.
MIDLOTHIAN MINE
WATER DISPOSAL PROPOSAL
Scale 1" = 1000' Environment Ontario
Date Jan 19, 1975 Sampling Locations
Rev. # 2

5.2 In early November/1974 the Ontario Ministry of the Environment conducted a sampling program to obtain data from the Lloyd Lake area prior to the start-up of the mine/mill complex (see also Appendix C - Background). A description of the following (5) locations are as follows. * Note after the November background study was completed, a six location was added.

No #1 - approximately three hundred feet east of Stanley Island (north tip)

No.#2 - small bay east of dam #3 (south of dam)

No.#3 - north-west bay of the north-east arm of Lloyd Lake (i.e. west of dam #4).

No.#4 - west of mill, one hundred to two hundred feet from potable water intake.

No.#5 - below ore zone, one hundred feet south of dam #1.

No.#6 - north-west bay of north-west arm of Lloyd Lake.*

Please refer to Water Diversion Proposal Page 72 sample location numbers are surrounded in a hexagon shaped figure.

During the water quality survey in November 1974 of Lloyd Lake, United Asbestos Inc. had started to remove the overburden from the ore zone on an occasional basis.

Because of the depth of the matrix and of the matrix containing virtually no asbestos it was generally thought that the data obtained could be utilized as background information.

The highest levels thus encountered were 0.07 x 10^6 fibres/litre from both of the following two (2) locations; the water intake (approximately 1000' from orebody) and the control point adjacent to Stanley Island (approximately 9000' from orebody).

In the winter of 1975 (February) a total of six (6) sample locations were analysed. The concentration of fibre at the control point at Stanley Island decreased somewhat in concentration from 0.07×10^6 fibres/litre to 0.02×10^6 fibres/litre; however, a slight increase in asbestos concentrations were noted near the water intake. (0.07×10^6 fibres/litre to 0.11×10^6 fibres/litre).

The above increase as mentioned earlier in this section does not differ, significantly in concentration, therefore, little emphasizes should be noted. However, in sampling the same location in March 1976., 1470×10^6 fibres/litre of total asbestos were found at the water intake location. Later in April 1976 at the same location the concentration of asbestos fibres rose to a high concentration of 3.1×10^9 fibres/litre, of this 0.7×10^9 fibres/litre were greater than 5 um. Later in the month from the same location concentrations of 8.4×10^9 fibres/litre and 38×10^9 fibres/litre from duplicate samples were found.

During the operations in both the mining and milling sector, it was quite evident that concentrations of asbestos in portions of Lloyd Lake were increasing at a rapid rate.

The main cause for elevated concentrations were the tailings deposition; (February, 1976, location #3 snow - 98.6 x 10^9 fibres/litre; water - 80.8 x 10^6 fibres/litre) and open pit operations near the water intake i.e. potable water at mill fountain (March 1976. 78.9 x 10^6 fibres/litre).

5.3 In conclusion, all concentrations of asbestos fibre in Lloyd Lake, Camp Lake (adjacent to work camp), Midlothian Lake and Bray Lake are tabulated in Appendix D.

Although the majority of asbestos can primarily be traced to aerial emissions; at this time it should be noted that the process water for cooling purposes in milling was discharged south-east of the mill.

Since this water contained substantial concentrations of fibre, an impervious dam was constructed to hopefully decrease the asbestos concentrations before it eventually made its way to Lloyd Lake via a swampy area.

In summation of this section, it is perhaps important to note that when United Asbestos Inc. was in operation substantial increases of chrysotile fibre were noted in certain sections of Lloyd Lake; however, since cessation of mining and milling all locations except the north-west bay of the north-east arm (15.8×10^6 fibres/litre) have returned to background levels obtained previously.

PART VI

FINAL SUMMATION AND INTERPRETATION OF DATA

PART VI

FINAL SUMMARY AND INTERPRETATION OF ANALYTICAL DATA

6.0 The mining and milling of chrysotile bearing ore has given way to numerous emission problems both in air and water.

6.1 AIR

Emissions will undoubtedly continue to pose a major problem from the open pit area of any future operation. It is a fact then, to eliminate emissions from primary and secondary blasting one would have to cover with some type of material, the area that will be ultimately effected. This is rather impossible. Therefore looking at it realistically one can possibly reduce aerial emissions by:

utilizing the proper concentration of explosive; location of explosive and depth so that complete combustion is achieved that will produce the required fracture of rock, but not necessarily expell material into the atmosphere.

Utilizing of liquid pastes in blasting holes etc. and multi-delay devices in curtailing emissions of asbestos to the environment.

All drilling rigs should be equipped with suitable bag filters.

The hauling of fractured ore to the primary crusher is a smaller source of airborne emissions. Possible wetting of the ore in transit and wetting of the ore in storage may reduce emissions somewhat.

Emissions from primary crushing of the ore can be curtailed by suitable dust collecting equipment on the crusher. The air in and around the primary ore slip should be slightly negative as to rid the area of emissions when the ore is loaded.

All transportation of the ore from the primary crusher to the mill ore storage area should be in covered conveyors.

Movement of ore from storage areas to secondary crushing should be done with caution as to prevent aerial emissions to the ambient atmosphere. i.e. doors should be closed as much as possible in storage buildings when material is shifted around.

All separating, cleaning and grading of fibres requires large volumes of air. As the installation of numerous cyclones not only increase milling efficiencies of asbestos and also decrease loadings to the central baghouse, it cannot be emphasized enough that possible overloading of the baghouse can occur when the mill increases input. The result are asbestos emissions to the exterior environment. Considering that the discharge from the central baghouse at United Asbestos Inc. mill building was located some 90' above grade, this compounded the emission problem by having the discharge (containing large quantaties of asbestos) picked-up by the wind. This incidentally would not happen if the baghouse was in proper working condition.

The deposition of coarse tailings and fine floats without proper wetting gave rise to gross emissions especially from the conveyor end drop-off point.

The flattening of the pile by earth-moving equipment also accelerated the above problem. In order to possibly alleviate the above problem to some extent, proper pugging of the tails and minimal movement of freshly deposited tailings by earth-moving equipment must take place.

WATER

6.2 Most asbestos operations including the operation of United Asbestos Inc. do not utilize a wet process technique. The only water utilized is for pugging, cooling and potable systems. It therefore stands to reason that the majority of emissions to the water are caused initially by aerial means.

It was noted that the dam #4 and especially dam #3 were to filter out asbestos fibres from entering the main portion of Lloyd Lake. Because of the delay in installing a suitable clay ore for dam #4, fibres have either migrated east of the dyke via water or have been transported via air east of the dam #4. The end result has been contamination to a part of the enclosed north-eastern section of the north-east arm of Lloyd Lake.

Possible runoff from the tailings deposition may also have been a cause for elevated concentrations of fibre in the north-west bay of the north-east arm of Lloyd Lake; especially in earlier spring as the tailings were, near the cessation of mining, 300' - 400' from the water.

6.3 The routine analytical data mentioned previously (Appendix B), does not show any abnormal concentrations of heavy metals etc.

The asbestos data, pertaining to United Asbestos Inc. Midlothian Mine/mill, has shown that

1) elevations did occur in the near vicinity of the mine/mill complex during the operational period.

2) high levels at most locations decreased at cessation of mining.

3) a high level of chrysotile fibre (15.8×10^6 fibres/litre was found adjacent to tailings deposition i.e. east of dam #4 at cessation of mining. This indicates that the tailings deposition area is still a problem location for aerial emissions even though the mining/milling operations have ceased.

PART VII

RECOMMENDATIONS

RECOMMENDATIONS

7.0 MINING

1) That all primary and secondary blasting associated with; 1) overburden removal, 2) road building, 3) site preparation and 4) open pit operations etc., be carried out in such a way as to reduce and minimize aerial emissions of asbestos fibres etc. to the ambient atmosphere by utilizing the BEST PRACTICABLE CONTROL TECHNOLOGY CURRENTLY AVAILABLE (BPCTCA)

2) All air track drills utilized for rock drilling be equipped with fabric dust collectors or centrifugal - fabric dust collectors for the suppression of dust and asbestiform material.

3) Waste rock facilities should possibly be ditched around the perimeter so that leaching can be held and treated.

4) Fragmented ore should be wetted with a suitable media when transported to primary crusher.

5) Primary crusher must be fitted with an approval bag filter system, and the bag filter system should be capable of producing a very slight negative pressure in the ore slip.

6) All outside conveyors should be operated at slow speeds; contain minimum transfer points; and be completely enclosed in conveyor galleries.

7) All dry and wet ore storage facilities should be completely enclosed and fitted with the approved pollution abatement equipment to decrease asbestos emissions to the immediate environment when movement of the ore by earth-moving equipment takes place.

8) All watercourses near, and above the present and future orebodies should be diverted to permit mining development to proceed without possible adverse environmental water problems.

Naturally this is also a safety feature when the orebody is located under a water body.

9) Low grade ore should not be used for road construction as natural leaching and weathering of the ore could cause the release of unwanted material into a watercourse etc.

10) A suitable media for wetting the ore haulage roads should be done on a frequent basis especially in the summer months.

7.1 MILLING

11) All ore dryers should be equipped with suitable dust collecting equipment so that the government criteria for particulate matter and asbestiform material is met. Also depending upon many factors, such a sulphur content in the fuel, it may be necessary to equip the dryer with sulphur dioxide scrubbers or some other abatement techniques as to meet the governments criteria for sulphur dioxide emissions.

12) All emission sources from the secondary crushing areas of a mill i.e. screening, impact crushers, and conveyors etc. should be directed to one source, if at all possible, for treatment. It may be necessary to direct all sources first through pre-cleaning cyclones, and a dirty air plenum before it enters the main mill baghouse system.

13) All emission sources from rock and fibre circuits i.e. grading, and transporting material from one aspiration screen to another should be also directed to a main mill baghouse as above (12) with a special emphasis being placed on total air volume to the main mill baghouse.

14) All spilled asbestos material and small rock fines that are located in the general areas of the mill i.e. primary crushing; secondary crushing and drying; rock circuit and fibre circuits should be removed as quickly as possible.

15) All floats and dust from the main mill baghouse should be mixed with a suitable media in a pug mill before being discharged to the main tailings belt. This includes winter months.

16) All medium and coarse tailings should be wetted after the pugged floats as to increase pugging efficiencies of the fine baghouse floats.

17) Hot air from the mill building should be directed to the outside enclosed tailings conveyor as to possibly prevent freezing, in the winter months, of the tailings.

18) Pug mill should be equipped with a flow recorder system and a weightometer as to properly pug the mill floats and to gain high pugging efficiencies during erratic operating conditions.

19) Pug mill should be equipped with a second back-up system including parallel conveyors and distribution system etc. so that tailings could be pugged when the main system experiences mechanical failures.

20) If, according to the Mines Inspection Branch of the Ontario Ministry of Labour, there appears to be an internal environmental air problem associated with the health and safety of workers employed directed in a certain section of the mill building and if, according to the Industrial Abatement Section of the Ontario Ministry of the Environment, there may possibly be an external environmental air problem associated with the same, it may be necessary for a trade-off with both parties concerned. This trade-off may be necessary because the technology to curtail internal and external emissions pertaining to a certain location may not be available to both interior and exterior environments combined.

7.2 TAILINGS DEPOSITION

21) It may be necessary, in future absestos mining/ milling operations, to examine the positive and negative factors regarding wet tailings disposal techniques (slurry) as compared to dry tailings disposal techniques.

22) Possible installation of a conical sleeve at the drop-off point of the final tailings conveyor as to alleviate primary asbestos emissions.

23) Frequent re-location of the tailings conveyor dumper as to minimize secondary emissions caused by the disturbance of tailings by large earth-spreading devices.

24) If dry disposal methods are to be used, then perhaps a grid system for tailings deposition should be carried out. This system or methodology is as follows:

The main tailings conveyor is extended from the mill building (prior to milling) to the farthest possible location. This location can be calculated on ore reserves and milling efficiencies. When a certain area is covered with tailings to an appropriate height (below land contours) the conveyor is retracted to the 2nd compartment or section. This in turn leaves the first area available for reclamation and stabilization techniques, including the ditching on three (3) sides of the said section (holding area for possible leachates) and the construction of a proper angle of repose for bank stability. If calculations regarding the ore reserves and mill efficiencies are moderately correct, then at the cessation of mining, all the tailings will have been deposited and only the last section need be stabilized.

7.3 DAMS

25) All future dam construction, especially in connection with the impermeable type, should contain an impermeable clay core or a suitable substance. If water movement is of concern then an overflow system with a permeable sand filter to filter asbestos fibres should be installed.

26) The freeboard height of the embankment from the maximum liquid level of all impermeable dams to the crest should not be less than three (3) feet.

27) All permeable dams should be constructed with a maximum filtration efficiency in mind. Fine gravel-like material should be placed in the interior sections of the rock crib so that maximum filtering of asbestos from the water can occur. Techniques should be used as to prevent the washing of the filter-type material from the dam.

28) Inspection by management personnel of all dams should be carried out on a frequent basis.

7.4 OTHER

29) All domestic garbage and material generated by the mine/mill operations i.e. packing cases etc. should be disposed of in a suitable means approved by the Ontario Ministry of the Environment.

30) All bulk petroleum facilities, bulk reagents etc. required by the mine/mill operations should be stored in a well defined area that is enclosed with an impermeable dyke in order to contain accidental spills.

31) All material, i.e. broken asbestos packing bags, should not be disposed of within the tailings mass. This type of practice can only hinder the character of asbestos as being hydrophilic.

32) Monitoring of air and water near an asbestos mine/mill operation should be done by the company on a frequent basis. The results should be sent to the appropriate section of the Ontario Government.

33) When plant upsets, spills etc. occur, the company should notify the appropriate regulatory body (Ontario Ministry of the Environment) as soon as possible.

34) Any modification etc. to a process or addition to must be first clarified by the Ontario Ministry of the Environment.

35) All product asbestos being transported from the operations to market should be enclosed in a suitable container and notification to the Ontario Ministry of the Environment should be made promptly if a container(s) is broken in transit.

36) Should the necessity arise to drain or divert, waters affiliated with the natural drainage of Lloyd Lake or Lloyd Lake thereof; a public hearing must be held <u>prior</u> to the undertaking.

APPENDIX A

EMISSION FACTORS

APPENDIX A

Emission Factors

Generally speaking, emission factors for mining and milling operations of chrysotile asbestos in Ontario are very difficult to estimate because of the wide variation.

Davis and Associates have estimated 93 lbs/ton of asbestos producted based on the following facts below.

ASBESTOS EMISSIONS FACTORS FOR MINING AND MILLING*
(pounds per tons of asbestos produced)

	Uncontrolled	Cyclone	Baghouse	Emission Factor
Mining	x			3
Loading	x			2
Hauling	x			2
Unloading	x			2
Crushing & Drying		x		10
Milling		x	x	64
Tailings	x			10
				93

* Based on baghouse efficiency @ 99.5% and cyclone efficiency @ 80%.

APPENDIX B

DISEASES ASSOCIATED WITH ASBESTOS

APPENDIX B

Diseases Associated with Asbestos

The relationship between asbestos exposure and respiratory illness was established a number of years ago. The formation of pleural calcification and plaques have been linked to asbestos. It also appears that asbestos may, after a latent period of thirty to forty years, cause cancer of the lungs and mesothelima of the respiratory lungs and gastrointestinal tracts. The actual mechanisms surrounding the above and exposure duration remain, as of to-day, a controversal topic.

The following diseases are associated with asbestos.

1) Asbestosis

This is one variety of the lung disease called "Pneumoconiosis". It is a progressive fibrosis of the lung which can make breathing difficult and can lead to other disabilities.

It has been shown that, when a level of exposure is reduced the incident of asbestosis is also reduced.

2) Bronchogenic Cancer

There is now medical evidence to indicate that asbestos exposure is associated with an increased frequency of bronchogenic cancer in workers who have first developed asbestosis. At the present time, little is known as to what causes the cancer, whether it is the chemistry of the asbestos, the fibrous nature of the material, or something else quite unrelated. There are many other known carcinogens, which include cold tar, benzidine, tobacco, vinylchloride, X-Rays and even sunshine.

3) Mesothelioma

Mesothelioma is one of those rare and newly recognized cancer diseases and is a malignant tumor of the lining membrane of the chest and abdominal cavity. By no means are all such tumors associated with asbestos, but where a relationship can be established, the exposure has largely been crocidilite (blue asbestos).

Far fewer cases have been found where the exposure was limited to chrysotile fibre which is the type mined in Canada. Investigations of 236 known cases of Mesothlioma in Canada between 1960 and 1970 show that only 9 were associated in any way with the Quebec chrysotile mining and milling industries. Seven men have been employed and 2 were women whose father's worked in the industry.

EXERPT FROM THE NORTHERN MINER PRESS (1975)

APPENDIX C

GENERAL BACKGROUND DATA OF LLOYD LAKE

APPENDIX C

GENERAL BACKGROUND DATA OF LLOYD LAKE

Location No. #1 - approximately three hundred feet east of Stanley Island (North tip)

Date Sampled - February 14, 1977

Note 1 ug/ml = 1 ppm = 1 mg/l.

Aluminum	(Al)	<	0.04	ug/ml
Cadmium	(Cd)	<	0.001	ug/ml
Molybdenum	(Mo)	<	0.001	ug/ml
Cobalt	(Co)	<	0.004	ug/ml
Copper	(Cu)		0.008	ug/ml
Iron	(Fe)		0.012	ug/ml
Lithium	(Li)	<	0.001	ug/ml
Manganese	(Mn)		0.004	ug/ml
Strontium	(Sr)		0.007	ug/ml
Nickel	(Ni)		0.002	ug/ml
Silver	(Ag)	<	0.002	ug/ml
Chromium	(Cr)		0.003	ug/ml
Zinc	(Zn)		0.005	ug/ml
Lead	(Pb)		0.004	ug/ml
Selenium	(Se)	≤	0.002	ug/ml
Barium	(Ba)		0.008	ug/ml
Magnesium	(Mg)		2.8	ug/ml

Biochemical Oxygen Demand (5)	(BOD)	1.0 ug/ml	
Chemical Oxygen Demand	(COD)	< 20 ug/ml	
Chloride (Cl)	1 ug/ml		
Total Organic Carbon	(TOC)	5 ug/ml	
Colour 5			
Nitrite (NO_2)	< 0.02 ug/ml		
Nitrate (NO_3)	< 0.2 ug/ml		
Specific Conductance	68		
Suspended Solids	< 15 ug/ml		
Acidity ($CaCO_3$)	3.4		
Alkalinity ($CaCO_3$)	24		
Free Ammonia (NH_3)	0.2 ug/ml		
Hardness	38		

No. 1 Location (Cond't)

pH		6.6
Sulphate	(SO_4)	14 ug/ml
Total Kjeldahl Nitrogen		0.5 ug/ml
Total Phosphorus	(P)	0.04 ug/ml
Turbidity	(FTU)	0.7
Arsenic	(As)	< 5 ug/l (ppb)
Calcium	(Ca)	7.1 ug/ml
Fluoride	(Fl)	< 0.1 ug/ml
Phenol		0
Solvent Extractable		2 ug/ml

LOCATION NO. #2 - Small Bay East of Dam No.#3 (South of dam)

Aluminum	(Al)	< 0.04 ug/ml
Cadmium	(Cd)	< 0.001 ug/ml
Molydbenum	(Mo)	< 0.001 ug/ml
Cobalt	(Co)	< 0.004 ug/ml
Copper	(Cu)	0.012 ug/ml
Iron	(Fe)	0.010 ug/ml
Lithium	(Li)	< 0.001 ug/ml
Manganese	(Mn)	0.003 ug/ml
Strontium	(Sr)	0.018 ug/ml
Nickel	(Ni)	0.002 ug/ml
Silver	(Ag)	< 0.002 ug/ml
Chromium	(Cr)	0.003 ug/ml
Zinc	(Zn)	0.005 ug/ml
Lead	(Pb)	0.004 ug/ml
Selemium	(Se)	≤ 0.002 ug/ml
Barium	(Ba)	0.009 ug/ml
Magnesium	(Mg)	3.3 ug/ml

Biochemical Oxygen Demand (5)	(BOD)	0.6 ug/ml
Chemical Oxygen Demand	(COD)	< 20 ug/ml
Chloride	(Cl)	1 ug/ml
Total Organic Carbon	(TOC)	7 ug/ml
Colour	15	
Nitrite	(NO_2)	< 0.02 ug/ml
Nitrate	(NO_3)	< .2 ug/ml
Specific Conductance		75
Suspended Solids		< 15 ug/ml
Acidity	($CaCO_3$)	1.0 ug/ml
Alkalinity	($CaCO_3$)	24 ug/ml
Free Ammonia	(NH_3)	0.2 ug/ml

Location No. #2 (Cond't)

Hardness		35
pH		6.8
Sulphate		14 ug/ml
Total Kjeldahl Nitrogen		0.4 ug/ml
Total Phosphorus	(P)	0.02 ug/ml
Turbidity	(FTU)	.60
Arsenic	(As)	< 5 ug/l (ppb)
Calcium	(Ca)	7.7 ug/ml
Fluoride	(Fl)	< .1 ug/ml
Phenol		0
Solvent Extractables		3 ug/ml

LOCATION #3 North-west bay of north-east arm of Lloyd Lake (i.e. west of dam No. #4)

Aluminum	(Al)	0.04 ug/ml
Cadmium	(Cd)	< 0.00' ug/ml
Molybdenum	(Mo)	< 0.001 ug/ml
Cobalt	(Co)	< 0.004 ug/ml
Copper	(Cu)	0.008 ug/ml
Iron	(Fe)	0.011 ug/ml
Lithium	(Li)	< 0.001 ug/ml
Manganese	(Mn)	0.004 ug/ml
Strontium	(Sr)	0.017 ug/ml
Nickel	(Ni)	0.003 ug/ml
Silver	(Ag)	0.002 ug/ml
Chromium	(Cr)	< 0.002 ug/ml
Zinc	(Zn)	0.003 ug/ml
Lead	(Pb)	0.004 ug/ml
Selenium	(Se)	≤ 0.002 ug/ml
Barium	(Ba)	0.009 ug/ml
Magnesium	(Mg)	3.2 ug/ml

Biochemical Oxygen Demand (5)	(BOD)	0.8 ug/ml
Chemical Oxygen Demand	(COD)	< 20 ug/ml
Chloride	(Cl)	
Total Organic Carbon	(TOC)	6 ug/ml
Colour		15
Nitrite	(NO_2)	< 0.02 ug/ml
Nitrate	(NO_3)	< 0.02 ug/ml
Specific Conductance		74
Suspended Solids		< 15 ug/ml

LOCATION NO. #3 (Cond't)

Acidity	($CaCO_3$)	2.0 ug/ml
Alkalinity	($CaCO_3$)	
Free Ammonia	(NH_3)	0.2 ug/ml
Hardness		34
pH		6.9
Sulphate	(SO_4)	14 ug/ml
Total Kjeldahl Nitrogen		0.4 ug/ml
Total Phosphorus	(P)	.02 ug/ml
Turbidity	(FTU)	.45
Arsenic	(As)	.5 ug/l(ppb)
Calcium	(Ca)	7.7 ug/ml
Fluoride	(Fl)	0.1 ug/ml
Phenol		0
Solvent Extractables		2 ug/ml

LOCATION NO. #4 West of mill one hundred to two hundred feet from potable water intake

Aluminum	(Al)	< 0.04 ug/ml
Cadmium	(Cd)	<< 0.001 ug/ml
Molybdenum	(Mo)	<< 0.001 ug/ml
Cobalt	(Co)	< 0.004 ug/ml
Copper	(Cu)	0.009 ug/ml
Iron	(Fe)	0.020 ug/ml
Lithium	(Li)	< 0.001 ug/ml
Manganese	(Mu)	0.003 ug/ml
Strontium	(Sr)	0.022 ug/ml
Nickel	(Ni)	0.006 ug/ml
Silver	(Ag)	< 0.002 ug/ml
Chromium	(Cr)	< 0.002 ug/ml
Zinc	(Zn)	0.010 ug/ml
Lead	(Pb)	0.007 ug/ml
Selenium	(Se)	≤ 0.002 ug/ml
Barium	(Ba)	0.016 ug/ml
Magnesium	(mg)	5.7 ug/ml

Biochemical Oxygen Demand	(5)	(BOD)	1.4 ug/ml
Chemical Oxygen Demand		(COD)	< 20 ug/ml
Chloride	(Cl)		2 ug/ml
Total Organic Carbon		(TOC)	7 ug/ml
Colour			20
Nitrite	(NO_2)		< .02 ug/ml
Nitrate	(NO_3)		<0.2 ug/ml
Specific Conductance			130
Suspended Solids			< 15 ug/ml

LOCATION NO. #4 (Cond't)

Acidity	($CaCO_3$)	2.0 ug/ml
Alkalinity	($CaCO_3$)	25 ug/ml
Free Ammonia	(NH_3)	0.2 ug/ml
Hardness		64
pH		7.0
Sulphate	(SO_4)	15 ug/ml
Total Kjeldahl Nitrogen		0.4 ug/ml
Total Phosphorus	(P)	0.04 ug/ml
Turbidity	(FTU)	.6
Arsenic	(As)	< 5ug/l (ppb)
Calcium	(Ca)	15 ug/ml
Fluoride	(Fl)	0.1 ug/ml
Phenol		0
Solvent Extractables		2 ug/ml

LOCATION NO. #5 below ore zone, one hundred feet south of dam No. #1

Aluminum	(Al)	< 0.04 ug/ml
Cadmium	(Cd)	<0.001 ug/ml
Molybdenum	(Mo)	<0.001 ug/ml
Cobalt	(Co)	<0.004 ug/ml
Copper	(Cu)	0.023 ug/ml
Iron	(Fe)	0.016 ug/ml
Lithium	(Li)	< 0.001 ug/ml
Manganese	(Mn)	0.003 ug/ml
Strontium	(Sr)	0.019 ug/ml
Nickel	(Ni)	0.002 ug/ml
Silver	(Ag)	< 0.002 ug/ml
Chromium	(Cr)	< 0.002 ug/ml
Zinc	(Zn)	0.013 ug/ml
Lead	(Pb)	0.008 ug/ml
Selenium	(Se)	≤ 0.002 ug/ml
Barium	(Ba)	0.011 ug/ml
Magnesium	(Mg)	3.4 ug/ml

Biochemical Oxygen Demand	(5)	(BOD)	0.4 ug/ml
Chemical Oxygen Demand		(COD)	< 20 ug/ml
Chloride	(Cl)		1 ug/ml
Total Organic Carbon		(TOC)	7 ug/ml
Colour			15
Nitrite	(NO_2)		.02 ug/ml
Nitrate	(NO_3)		< 0.2 ug/ml
Specific Conductance			78
Suspended Solids			< 15 ug/ml
Acidity			2.0 ug/ml
Alkalinity			11 ug/ml

LOCATION NO. #5 (Cond't)

Free Ammonia	(NH_3)	0.2 ug/ml
Hardness		36
pH		7.1
Sulphate	(SO_4)	14 ug/ml
Total Kjeldahl Nitrogen		0.4 ug/ml
Total Phosphorus	(P)	0.02 ug/ml
Turbidity	(FTU)	.45
Arsenic	(As)	< 5ug/l (ppb)
Calcium	(Cu)	8.6 ug/ml
Fluoride	(Fl)	< 0.1 ug/ml
Phenol		0
Solvent Extractables		2

LOCATION NO. #6 - north-west bay of north - west arm of Lloyd Lake

Aluminum	(Al)	< 0.04 ug/ml
Cadmium	(Cd)	< 0.001 ug/ml
Molybdenum	(Mo)	< 0.001 ug/ml
Cobalt	(Co)	< 0.004 ug/ml
Copper	(Cu)	0.009 ug/ml
Iron	(Fe)	0.014 ug/ml
Lithium	(Li)	0.001 ug/ml
Manganese	(Mn)	0.003 ug/ml
Strontium	(Sr)	0.019 ug/ml
Nickel	(Ni)	0.003 ug/ml
Silver	(Ag)	< 0.002 ug/ml
Chromium	(Cr)	< 0.002 ug/ml
Zinc	(Zn)	0.005 ug/ml
Lead	(Pb)	0.004 ug/ml
Selenium	(Se)	≦ 0.002 ug/ml
Barium,	(Ba)	0.011 ug/ml
Magnesium	(Mg)	3.5 ug/ml

Biochemical Oxygen Demand	(5)	(BOD)	0.6 ug/ml
Chemical Oxygen Demand		(COD)	< 20 ug/ml
Chloride	(Cl)		1 ug/ml
Total Organic Carbon		(TOC)	6 ug/ml
Colour			5
Nitrite	(NO_2)		< .02 ug/ml
Nitrate	(NO_3)		0.2 ug/ml
Specific Conductance			78
Suspended Solids			< 15 ug/ml
Acidity	($CaCO_3$)		2.0 ug/ml
Alkalinity	($CaCO_3$)		
Free Ammonia	(NH_3)		0.2 ug/ml

LOCATION NO. #6 (Cond't)

Hardness		35
pH		7.1
Sulphate	(SO_4)	15 ug/ml
Total Kjeldahl Nitrogen		0.4 ug/ml
Total Phosphorus	(P)	0.02 ug/ml
Turbidity	(FTU)	.60 ug/ml
Arsenic	(As)	< 5 ug/l (ppb)
Calcium	(Ca)	8.7 ug/ml
Fluoride	(Fl)	< 0.1 ug/ml
Phenol		0
Solvent Extractables		3

APPENDIX D

ONTARIO MINISTRY OF THE ENVIRONMENT

SAMPLING DATA

APPENDIX D

UNITED ASBESTOS INC. AMPHIBOLE AND CHRYSOTILE ASBESTOS
ONTARIO MINISTRY OF THE ENVIRONMENT
DATA

LEGEND

CHRYSOTILE - $Mg_6 (OH)_8 Si_4O_{10}$

Chemical breakdown:

SiO_2 = 37 - 44%
MgO = 39 - 44%
FeO = 0.0 - 6%
Fe_2O_3 = 0.1 - 5%
Al_2O_3 = 0.2 - 1.5%

AMBHIOLE - general term to describe the following (A more complex structure than serpentine asbestos): crocidolite, amosite, anthophyllite, tremolite and actinolite.

ORF - Ontario Research Foundation (Dr. E. J. Chatfield)
MU - McMaster University (Dr. J. R. Kramer)
MOE - Ministry of the Environment (Dr. J. A. Pimenta)
BDL - Below Detection Limit (2.3 x 10^6 fibres/l)
ug/l - micrograms per litre
UAI - United Asbestos Incorporated
N.D. - Non-detectable

LOCATIONS OF SAMPLING () refers to map	DATE OF SAMPLING MOE	DATE OF SAMPLING UAI	ORF	MU	MOE	AMPHIBOLE	CHRYSOTILE	CONCENTRATION fibres/litre	CONCENTRATION fibres/litre 5 UM	CONCENTRATION ug/l
300' east of Stanley Island (1)	Nov./74		*			N.D.	*	0.07×10^6		
Small bay east of dam #3 (2)	Nov./74		*			N.D.	*	0.04×10^6		
North-west bay of North-east arm- Lloyd Lake (3)	Nov./74		*			N.D.	 *	0.02×10^6 0.02×10^6		
West of Mill 100' - 200' from water intake (4)	Nov./74		*			N.D.		0.07×10^6		
Below ore Zone 100' south of dam #1 (5)	Nov./74		*			N.D.		0.02×10^6 0.02×10^6		
300' east of Stanley Island (1)	Feb/75		*				*	0.02×10^6		

LOCATIONS OF SAMPLING () refers to map	DATE OF SAMPLING MOE	DATE OF SAMPLING UAI	DORF	MU	MOE	AMPHIBOLE	CHRYSOTILE	CONCENTRATION fibres/litre	CONCENTRATION fibres/litre 5 UM	CONCENTRATION ug/l
Small bay east of Dam #3 (2)	Feb./75		*				*	0.09×10^6		
North-west bay of North-east Arm - Lloyd Lake (3)	Feb./75		*				*	0.11×10^6		
West of Mill 100 - 200' from Water Intake (4)	Feb./75		*				*	0.15×10^6		
Below ore zone 100' south of Dam #1 (5)	Feb./75		*				*	0.04×10^6		
North-west bay at North-west arm of Lloyd Lake (6)	Feb./75		*				*	0.02×10^6		
Grassy River 1000' downstream from bridge (Wawaitin Rd)	Aug./75		*			N.D.	*	0.05×10^6 0.10×10^6		

LOCATIONS OF SAMPLING () refers to map	DATE OF SAMPLING MOE	DATE OF SAMPLING UAI	ORF	MU	MOE	AMPHIBOLE	CHRYSO-TILE	CONCENTRATION Fibres/Litre	CONCENTRATION Fibres/Litre 5 UM	CONCENTRATION ug/l
Inlet to Timmins Water Filtration Plant	Aug./75		*			* N.D.	*	0.05×10^6 $0.10 \times 10.^6$		
(3) Snow sample north-west bay of north-east arm Lloyd Lake	Feb./76		*			*N.D.	*	850×10^6 98600×10^6 (98.6×10^9)		1.5×10^3
Water under ice north-west bay of north-east arm of Lloyd Lake (3)	Feb./76		*			*N.D.	*	0.62×10^6 80.8×10^6		1.11×10^3
30' east of Dam #4		Feb./76	*			N.D.	*	1510×10^6		
150' from potable water intake (close to 4)		Mar./76	*			N.D.	*	1470×10^6		
Drinking water at Tap		Mar./76	*			N.D.	*	78.9×10^6		

LOCATIONS OF SAMPLING () refers to map	DATE OF SAMPLING MOE	DATE OF SAMPLING UAI	ORF	MU	MOE	AMPHIBOLE	CHRYSO-TILE	CONCENTRATION Fibres/Litre	CONCENTRATION Fibres/Litre 5 UM	CONCENTRATION ug/l
Potable water intake (4)		Mar./76	*			N.D.	*	402×10^6		
Drinking water ahead of chlorin-ation		Mar./76	*			N.D.	*	196×10^6		
25' east of Dam #4 (3)		Apr./76	*			N.D.	*	4700 / litre		
West of Mill 100 - 200' from water intake (4)	Apr./76				*		*	3.1×10^9	0.7×10^9	
Drinking water fountain	Apr./76				*		*	0.48×10^9		
West of Mill 100 - 200' from water intake (4)	Apr./76 Apr./76			 *	*		* *	8.4×10^9 38×10^9		Duplicate Duplicate

LOCATIONS OF SAMPLING () refers to map	DATE OF SAMPLING MOE	DATE OF SAMPLING UAI	ORF	MU	MOE	AMPHIBOLE	CHRYSOTILE	CONCENTRATION fibres/litre	CONCENTRATION fibres/litre 5 UM	CONCENTRATION ug/l
Drinking Water Fountain	Apr./76				*		*	2.1×10^9		Duplicate
	Apr./76			*			*	1.5×10^9		Duplicate
Camp Lake (Wilson's Camp)	Apr./76				*	*	BDL (2.3×10^6)	0.46×10^6		
Bray Lake	Apr./76				*		*	10.1×10^6		
Midlothian Lake	Apr./76				*		*	10.44×10^6	2.32×10^5	
East Side of Dam #4	May /76				*		*	75.2×10^6	0.45×10^5	
West Side of Dam #4 (3)	May/76				*		*	459.4×10^6	4.6×10^6	

LOCATIONS OF SAMPLING () refers to map	DATE OF SAMPLING MOE	DATE OF SAMPLING UAI	ORF	MU	MOE	AMPHIBOLE	CHRYSO-TILE	CONCENTRATION Fibres/Litre	CONCENTRATION Fibres/Litre 5 UM	CONCENTRATION ug/l
300' east of Stanley Island (1)	May/77				*	BDL	*	0.55×10^6		
Small bay east of dam #3 (2)	May/77				*	BDL	*	15.8×10^6		
North-west bay of North-east arm Lloyd Lake (3)	May/77				*	BDL	*	2.2×10^6		
West of Mill 100' - 200' from water intake (4)	May/77				*	BDL	*	BDL detection limit 0.55×10^6		
Below Ore Zone 100' south of Dam #1 (5)	May/77				*	BDL	*	1.1×10^6		
North-west bay of North-west arm- Lloyd Lake (6)	May/77				*	BDL	*	1.4×10^6		

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CHRISTOPHER R. GIBSON


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